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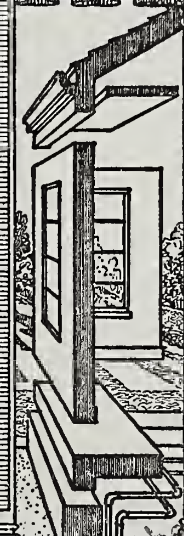
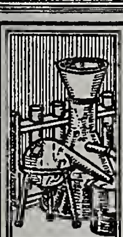


REPORT BMS70

Asphalt-Prepared Roll Roofings and Shingles

by

HUBERT R. SNOKE



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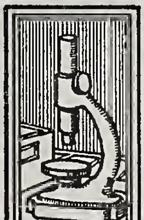

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BUILDING MATERIALS *and* STRUCTURES

REPORT BMS70

Asphalt-Prepared Roll Roofings and Shingles

by

HUBERT R. SNOKE

ISSUED APRIL 10, 1941

The National Bureau of Standards is a fact-finding organization; it does not "approve" any particular material or method of construction. The technical findings in this series of reports are to be construed accordingly.

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Foreword

This report is the second of a series dealing with the properties and applications of roofing materials suitable for use in low-cost house construction. The first, Metallic Roofing for Low-Cost House Construction, has been published as Building Materials and Structures Report BMS49, copies of which may be obtained as described on cover page III.

Asphalt-prepared roofings, the subject of the present report, while comparative newcomers in the field of roofing, are widely used today. Available literature on this subject is mainly of a technical or an advertising nature. The purpose of this report is to furnish information that will be of value not only to architects, engineers, specification writers, and roofing contractors but also to the average home owner.

LYMAN J. BRIGGS, *Director.*

Asphalt-Prepared Roll Roofings and Shingles

BY HUBERT R. SNOKE

CONTENTS

ABSTRACT

Asphalt-prepared roofings are defined, their development is sketched briefly, and recent statistics of production are presented. Factors which influence the choice of roofing materials generally are discussed.

Materials used in the manufacture of asphalt-prepared roofings and the processes of manufacture are described. Analyses of typical roofings are shown.

Factors which should be considered in purchasing asphalt-prepared roll roofings and shingles are discussed, and illustrated graphically for types of shingles that are used most generally. Methods of application and maintenance are described, and the weathering of asphalt-prepared roofings is discussed.

I. INTRODUCTION

1. HISTORICAL

The asphalt-prepared roofing industry had its beginning in Sweden more than a century ago, when roof boards were covered with paper treated with wood tar. Later, in Germany, paper was coated with varnish, surfaced with finely ground mineral matter, and used as a roofing material.

In the United States, asphalt was used to waterproof duck fabric in the early part of the

nineteenth century. The first recorded use of melted asphalt for impregnating duck fabric in this country was in 1844. About this time roofs composed of sheets of sheathing paper treated with pine tar and pine pitch, and surfaced with fine sand, were being laid. Coal tar and coal-tar pitch were later substituted for the pine tar. These were the forerunners of the present asphalt and coal-tar-pitch built-up roofs.

It is not known definitely when felt was first substituted for sheathing paper or when asphalt was first used as the impregnating agent, but it is known that the first asphalt-prepared roofing, that is, roofing manufactured ready to apply, was marketed in 1893. The first roofings were unsurfaced.

Mineral-surfaced, asphalt-prepared roofings appeared in 1897. The first asphalt shingles, mineral-surfaced, were made in 1901, and about this time slate granules were first used as a surfacing material. Asphalt shingles did not come into general use until about 1911.

During 1939, thirty-two manufacturers, representing about 95 percent of the asphalt-prepared roofing industry, produced 34,225,187 squares [1] of prepared roofing. Almost one-third of this, 11,173,856 squares, was in the form of asphalt shingles, which are used principally for roofing dwellings. The shingles produced in 1939 were sufficient to cover more than 1,000,000 dwellings, assuming an average size of 10 squares per roof.

In two surveys of roofing materials in 20 Eastern States,[2] made during 1938, the kinds of roofing materials on 20,841 dwellings along 4,038 miles of highway were tabulated. Of these dwellings, 6,549 were roofed with asphalt shingles and 2,381 with asphalt roll roofing. Thus almost 43 percent of these dwellings were roofed with asphalt-prepared roofings. Statistics of the Bureau of the Census indicate that asphalt-prepared roll roofings and shingles constituted slightly less than half of all the roofing materials sold during 1937.

It is apparent from the foregoing that this industry has grown to enormous proportions within a relatively short period.

2. General

The fundamental function of any roof is to protect the interior of a structure, its contents and occupants, from the weather. The property most desired in roofing materials is waterproofness, both initially and during long periods of exposure. Some factors other than waterproofness that influence the choice of roofing materials are weather resistance; appearance; fire resistance; ease of application; weight; availability; and cost, initial and ultimate. No attempt has been made to list these factors in the order of relative importance. Initial cost, particularly, is an extremely potent factor, as evidenced by the widespread use of low-cost materials. Proof that availability is a governing factor is furnished by the almost exclusive use of slate roofs in regions where slate quarries are located. The ready availability of asphalt-prepared roofings, with more than 90 plants making them in 25 States, contributes to their extended use. Fire resistance is also important; fireproof and fire-resistant roofing materials are given lower insurance rates; also, building codes usually restrict the use of roofing materials in congested areas on the basis of fire resistance. Ease of application is of great interest to home owners who wish to apply their own roofs, or in any case where the cost of labor is important. Appearance has always been emphasized as an important factor and, apparently, is becoming increasingly more important.

Asphalt-prepared roofings generally may be classed as being suitable for low-cost house construction. They have been made readily available throughout the country, are relatively easy to apply, and may be obtained in a variety of weights up to 375 pounds per square. When made and applied according to the specifications of the Underwriters' Laboratories, Inc., these roofings are eligible to receive the class *C* label,[3] which identifies them as being "effective against light fire exposure", that is, they are "not readily flammable and do not readily carry or communicate fire; afford at least a slight degree of heat insulation to the roof deck; do not

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[1] A square of roofing is material sufficient to cover 100 square feet of roof surface. The term "square" is also used in the industry to indicate 100 square feet of roof surface.

[2] Hubert R. Snoke, and Leo J. Waldron, Building Materials and Structures Reports BMS6, Survey of Roofing Materials in the Southeastern States; and BMS29, Survey of Roofing Materials in the Northeastern States. See cover page III.

[3] List of Inspected Fire Protection Equipment and Materials, January 1940, Underwriters' Laboratories, Inc., 207 E. Ohio St., Chicago, Ill.

slip from position; possess no flying brand hazard; and may require occasional repairs or renewals in order to maintain their fire-resisting properties."

Since they are manufactured products, asphalt-prepared roofings may be obtained in many designs and in a wide range of colors. They are inherently waterproof, but, in common with other roofing materials, the waterproofness of roofs constructed from them depends largely on the design of the roofing and the skill with which it is applied. Asphalt-prepared roofings as produced today are weather-resistant, but they are not unaffected by exposure to the weather. No definite statement can be made concerning the useful life of these materials, for this will vary in different locations and with the conditions of exposure in the same location. They have been available generally for only about 30 years, and during that time a great many have been replaced or recovered.

The literature on asphalt-prepared roofings is relatively meager, owing to the fact that they have been developed within a comparatively short time, a considerable part of which might be described as a period of development. At present, the raw materials and manufacturing processes are more or less standardized, yet the producers of asphalt-prepared roofings are constantly investigating new and different raw materials, new designs of shingles, and new and improved processes of manufacture.

Any manual that would attempt to furnish detailed information concerning all prepared roofings would, therefore, soon be out of date. The purpose of this publication is to discuss the subject of asphalt-prepared roofing in general terms, and to give some detailed information concerning fundamental factors that should be considered in purchasing any type of prepared roofing, with particular reference to certain definite kinds that may be classed as standard types, since they are produced by practically all the manufacturers.

The average owner of a dwelling usually gives but little consideration to his roof until it needs repair or replacement and, consequently, has but little knowledge of roofing materials in general. Unfortunately, the salesman who attempts to sell him a new roof may be but little, if any, better informed. As a consequence, price is too often the determining factor. Without question, many purchasers of inferior roofing materials would actually prefer the better materials if the advantages of the better materials were made plain.

II. DEFINITION OF ASPHALT-PREPARED ROOFING

Asphalt-prepared roofing may be defined as roofing made with a felt base, impregnated with asphalt, and coated with a more viscous asphalt than that used in impregnating the felt. It is marketed ready to apply, either as long strips in rolls called roll roofing or in the form of relatively small pieces known as shingles. The roll roofing may be dusted on both sides with fine mineral matter, such as talc, mica, or fine sand, to prevent sticking in the rolls; or it may be coated on only one side with fine mineral matter and have coarse mineral granules embedded in the asphalt coating on the surface to be exposed to the weather. The first type is described as smooth-surfaced prepared roofing, the second as mineral-surfaced prepared roofing. Asphalt shingles are always mineral surfaced.

Several terms are used to describe these materials. Both smooth- and mineral-surfaced roll roofings are described as composition or ready roofings. Smooth-surfaced roofing is known as smooth roll roofing, paper roofing, tar-paper roofing, and, sometimes, as rubber roofing. Mineral-surfaced roofing is also known as grit roll roofing and slate-surfaced roofing. Asphalt shingles are described as composition shingles, slate-surfaced shingles, and, frequently, as asbestos shingles, though commonly they contain no asbestos fibers.

III. MATERIALS USED IN ASPHALT-PREPARED ROOFINGS

1. Felt

The felts used in asphalt-prepared roll roofings may be made from organic or asbestos fibers; those in asphalt shingles are almost invariably from organic fibers. Felts of both types are formed on a machine similar to that used in the manufacture of paper.

Felts made from organic fibers are usually described as "rag" felts, because they contain a large proportion of fibers obtained from graded rags. Originally, materials other than rags, particularly wood fibers, were considered as adulterants, but research has shown that roofings made from felts containing as much as 50 percent of certain materials other than rags may resist weathering as well as if not better than those made with all-rag felts.[4]

Analyses of typical organic felts are shown in table 1.[5]

TABLE 1.—*Fiber analysis of typical felts*

Sample No.	Rag	Ground wood	Chemical wood	Jute	Wool	Rayon	Silk	Hair	Kapok
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
1	53.5	16.9	8.3	11.8	2.3	4.5	1.6	0.8	0.3
2	50.7	17.8	8.2	10.2	4.7	1.6	3.0	.3	3.5
3	77.5	2.0	7.5	5.5	1.5	4.3	0.4	.6	------
4	59.3	6.2	9.2	10.2	7.1	2.5	3.3	1.5	0.6
5	50.2	18.8	13.3	4.6	0.5	6.6	3.9	------	------
6	55.4	11.2	14.0	14.9	1.5	1.9	0.7	0.1	------
7	65.8	17.3	5.3	6.9	3.6	0.5	.4	.3	------
8	54.5	5.2	18.3	8.8	1.5	9.6	1.9	------	------

Roofing felts are designated in the industry by "numbers" which are their weights in pounds per 480 sq. ft. Specifications for asphalt-prepared roofings usually specify the weight per 108 sq ft of felt. Typical felts used commonly in prepared roofings are shown in table 2.

Felts made entirely of asbestos fibers are not so satisfactory for the manufacture of prepared roofings as those containing some hair or cotton fibers, which tend to give the felts a more open texture and thus permit them to absorb more asphalt. Some binding material, such as starch, glue, dextrine, or aluminum silicate, is also necessary. Specifications for asbestos roofing felts usually require a minimum of 85 percent of asbestos fibers. Weights of asbestos felts are expressed in pounds per 108 sq ft.

2. ASPHALT

The asphalts used in prepared roofing are mainly of petroleum origin, that is, they are obtained as residues from the distillation of crude petroleum in the production of gasoline, fuel oil, lubricating oil, etc. Some natural asphalts are also used.

Petroleum asphalts of semisolid consistency, and free from mineral matter, are used to impregnate the felts. The impregnating asphalt is known as the "saturant". The weight of saturant is always expressed in terms of the weight of the dry felt as "percentage saturation". Thus a saturation of 175 percent indicates a weight of asphalt $1\frac{3}{4}$ times the weight of the dry felt, or, a saturated felt weighing 30 lb per 108 sq ft and having a saturation of 175 percent is composed of 10.9 lb of felt and 19.1 lb of asphalt.

Asphalts used for coating the felts are usually harder and always more viscous than those used as saturants. Roof temperatures of 140° F and higher are not unusual. Coating asphalts must not flow nor slip when exposed to these temperatures. The coatings of mineral-surfaced roofings are protected somewhat by the surfacing granules, but they must be able to hold the granules in place under the maximum temperatures that may be reached on a roof.

Coating asphalts usually contain fine mineral filler, which, in the case of petroleum asphalts, is added in order to increase the weather resistance of the coating. Mineral fillers added to coating asphalts were considered as adulterants in the early manufacture of prepared roofings. Research has shown, however, that the addition to coating asphalts of certain fine mineral fillers in proper proportions will definitely increase their resistance to the weather.[6]

3. SURFACING MATERIALS

Pulverized slate, talc, slag, and mica were among the first materials to be dusted on asphalt-prepared roofing to prevent sticking and also to produce a more uniform appearance. Talc and mica, both coarse and fine, are used for the same purposes today on smooth-surfaced prepared roofings and on the back of mineral-surfaced roll roofings and shingles.

The first use of larger surfacing granules was probably prompted by the added resistance to fire imparted by them. Fine gravel and feldspar chips were used originally, roofings surfaced with them being marketed about 1897. Crushed slate was used first about 1902 on roll roofings and about 1910 on asphalt shingles.

[4] O. G. Strieter, J. Research NBS **16**, 511 (1936) RP888.

[5] Hubert R. Snoke and Braxton E. Gallup, J. Research NBS **18**, 669 (1937) RP1002.

[6] O. G. Strieter, J. Research NBS **20**, 159 (1938) RP1073.

Crushed porcelain, brick, tile, and pottery were also among the early surfacing materials that were used to produce diverse color effects.

Prepared roofings in different colors and color combinations proved immediately popular. Consequently, a great amount of research has been employed in the development of synthetic surfacing materials, particularly those of brilliant colors not obtainable from the natural rocks or common ceramic materials.

Several types of colored granules are now in general use—namely, natural, fired, glazed, silicated, and cemented. Granules colored with baking enamels, lacquers, or stains were used formerly but have since been abandoned.

Natural granules are those obtained by crushing slate or other colored rocks, such as shale, quartz, greenstone, etc.

Fired granules are those produced by firing certain clays or shales at high temperatures, with or without the addition of metallic oxides to produce colors.

Glazed granules are made from somewhat porous refractory rocks, such as quartzite. A common method is to treat the rock, screened to proper size, with a water-soluble glaze composed of a coloring agent and a fluxing agent. After drying, the granules are fired at a temperature from 1,000° to 2,200° F. At present most of the synthetically colored granules are made by this or a somewhat similar method.

Silicated granules are those in which sodium silicate is used as the fusing and glazing agent in combination with coloring agents. Silicated coatings are frequently applied to slate granules.

Cement-coated granules are those coated with a cementing mixture which forms a hard insoluble coating, either at normal or elevated temperatures.

4. Composition of Typical Roofings

Specifications for asphalt-prepared roll roofings and shingles issued by the Federal Government, the American Society for Testing Materials, and the Underwriters' Laboratories, Inc., are listed at the end of this report. The Federal Specifications and those of the American Society for Testing Materials are limited in their requirements to the composition and weight per unit area of the material. Those of the Underwriters' Laboratories, Inc. include requirements for the composition and weight of the material and also recognize certain features of application.

Roofings of the same type, produced by different manufacturers, show but little variation in composition. There are several reasons for this uniformity. From the beginning the asphalt-prepared roofing industry, although highly competitive, has established standards of weight for their finished products of the same class. The fundamental parts of the machines used to produce these roofings are complicated and expensive, and are available from only a few sources. Sources of supply of felt, surfacing granules, and mineral fillers are somewhat limited, so that it is not unusual for several producers to obtain these materials from a common source. Another factor that tends to produce uniformity of composition in materials from large and small manufacturers is the inspection service conducted by the Underwriters' Laboratories, Inc., in connection with their labeling service. Prepared roofings must comply with the minimum requirements of the Underwriters' Laboratories as regards composition and application in order to be eligible for the class *C* label.

Table 2.—*Smooth-surfaced asphalt-prepared roll roofings* [1]

Sample No.	Grade	Weight of felt	"Number" of felt	Saturation	Weight of saturant	Weight of coatings and fine surfacing	Weight of roofing
	lb	*lb/108 ft²*		%	*lb/108 ft²*	*lb/108 ft²*	*lb/108 ft²*
1	35	6.7	30	150	10.0	15.8	32.5
2		4.7	21	150	7.1	20.2	32.0
3		7.6	34	157	11.9	12.5	32.0
4		6.5	29	145	9.4	16.1	32.0
5		4.5	20	150	6.8	21.7	33.0
6	45	7.9	35	150	11.9	22.7	42.5
7		8.1	36	155	12.6	21.3	42.0
8		11.3	50	162	18.3	12.4	42.0
9		9.5	42	164	15.6	16.9	42.0
10		11.7	52	175	20.5	10.8	43.0
11	55	11.3	50	160	18.1	23.1	52.5
12		11.3	50	186	21.0	19.7	52.0
13		13.0	58	181	20.5	18.5	52.0
14		11.9	53	183	21.8	13.3	47.0
15		11.7	52	175	20.5	20.8	53.0
16	65	13.5	60	165	22.3	26.7	62.5
17		14.6	65	195	28.5	18.1	62.0
18		14.2	63	185	26.3	21.5	62.0
19		13.5	60	165	22.3	21.2	57.0
20		12.2	63	185	26.3	22.5	63.0
21	75	16.4	73	175	28.7	28.4	73.5
22		16.9	75	195	33.0	22.1	72.0
23		16.2	72	191	30.9	24.9	72.0
24		14.0	62	180	25.2	27.8	67.0
25		14.2	63	185	26.3	32.5	73.0

[1] The 35- and 45-pound grades are not eligible for the class *C* label of the Underwriters' Laboratories, Inc.

The composition of representative smooth-surfaced asphalt-prepared roofings and asphalt shingles is shown in tables 2 and 3, respectively. In table 2, each roofing listed in the several grades represents a different producer. The shingles in table 3 are those from which the felts reported in table 1 were taken, the samples being numbered identically in the two tables, each sample representing a different producer. The uniformity of composition of these shingles may also be taken as representative of that of mineral-surfaced roll roofings.

TABLE 3.—*Composition of typical asphalt shingles*

Sample No.	Color	Felt					Asphalt			Mineral matter					
												Granular surfacing material		Mainly fine mineral filler	
		Weight	"Number" of felt (calculated)	Saturation	Thickness	Ash	Weight of saturant	Top coating	Bottom coating	Top	Bottom	Retained on No. 70 sieve	Type	Passing No. 70 sieve (percent of coating)	Nature of mineral matter passing No. 200 sieve
		lb/108 ft²		*Percent*	*in.*	*Percent*	*lb/108 ft²*	*lb/108 ft²*	*lb/108 ft²*	*lb/108 ft²*	*lb/108 ft²*	*lb/108 ft²*			
1	Natural green	10.4	46	192	0.049	9.8	20.0	18.9	0.9	36.8	0.7	28.9	Slate	32.9	[a] Silicate rock.
2	Natural red	11.1	49	205	.057	9.1	22.8	17.6	1.1	34.7	.5	29.6	do	26.0	Quartz.
3	Ceramic bright green.	11.8	52	195	.058	8.3	23.0	14.9	2.7	33.2	1.5	28.9	Quartz with fluxed green coating.	26.7	Dolomitic-limestone.
4	Blue-black	11.2	50	160	.051	8.3	17.9	19.3	4.0	31.9	2.6	22.2	Slate	35.6	Silicate rock, also slate flour.
5	Ceramic green	10.4	46	190	.054	11.0	19.8	14.2	5.0	33.7	2.0	29.6	Quartz with fluxed green coating.	29.4	Black slate flour.
6	Natural red	11.7	52	182	.052	8.0	21.3	15.1	0.9	37.2	1.2	29.9	Slate	36.3	Ground quartz.
7	Natural blue-black.	12.5	56	169	.057	8.8	21.1	16.8	1.7	33.8	0.8	25.5	do	34.9	Dark slate flour.
8	do	12.4	55	201	.061	8.1	24.9	26.1	1.2	22.4	1.6	21.8	do	9.6	Do.

[a] Ground rock in which basic minerals predominate.

The relative importance of the details of composition are not discussed at length here, because the average purchaser has little opportunity to judge these materials from the standpoint of composition. Also, the composition of prepared roofings furnishes no sure criterion of their behavior when exposed to the weather. Asphalts used as saturants and coatings, obtained from different sources, or from the same source but refined by different processes, produce roofings which behave differently on exposure. Roofings made from identical materials but with variations in the manufacturing process do not behave similarly.

Proper saturation is one of the most important details of composition. The voids in the felts of commercial roofings are never filled completely with asphalt, but the more nearly a felt approaches complete saturation, the better the service it will render. Felts that are not saturated adequately absorb water readily, and roofings made from them are likely to warp and blister on exposure. A light-weight felt saturated adequately is always more desirable than a heavy felt saturated inadequately. Reference to tables 2 and 3, and to the specifications listed at the end of this report, indicates that the heavier grades of roll roofings and the asphalt shingles carry the greatest saturation. Asphalt shingles, particularly, should be well saturated because the ratio of the exposed cut edges to the area is much greater with shingles than with roll roofings, which makes the possibility of moisture absorption through the edges of the shingles proportionately greater.

Asphalt coatings that adhere well to the saturated felt and to the granular surfacing materials should be used. In order to insure proper adhesion of the coating asphalt to the saturated felt, the asphalts used as coatings and saturant should be "compatible", that is, they should show no separation, either initially or after prolonged exposure.

IV. MANUFACTURE OF ASPHALT-PREPARED ROOFINGS

Asphalt-prepared roofings are usually manufactured on high-speed, continuously operat-

ing machines. In the simplest form of machine the felt enters as a dry sheet and passes over preheating rolls into the saturator, where it is thoroughly impregnated with asphalt. The saturated felt then passes through a looping system, where it is cooled somewhat, to the coating rolls, where the asphaltic coatings are applied to both sides of the sheet. While the coatings are still hot, the sheet is passed by the granule feeders where the mineral surfacing materials are applied, through rolls which embed the surfacing materials firmly in the coating. Then follows a series of cooling rolls and a looping device, which serve to cool the sheet before it passes to the automatic cutter and winder, if it is to be marketed as roll roofing, or to the shingle cutting and packaging machine, if shingles are being produced. Machines capable of producing 250 linear feet of roll roofing per minute are not uncommon, while some developed recently are said to produce up to 400 feet per minute.

So-called intermittent machines are those in which the felt is saturated, cooled, and wound into large rolls to be coated later.

Many variations have been proposed in the manufacturing process, each intended to secure a better product or increased production.

Briefly, the composition of prepared roofings and the processes of manufacture are items over which the occasional purchaser has no control, and about which he would not have sufficient information to serve as a basis for differentiating between the various products of the same class. There are, however, certain very important factors in the choice of asphalt-prepared roofings which are subject to the judgment of the occasional purchaser. Some of these factors are discussed in succeeding sections.

V. FACTORS WHICH SHOULD BE CONSIDERED IN PURCHASING ASPHALT-PREPARED ROOFINGS

1. Roll Roofings

The preliminary choice in roll roofings is between the smooth- and mineral-surfaced varieties. Smooth-surfaced roofings generally have the lowest initial cost and have the least to recommend them from the standpoint of appearance. They are subject to more rapid deterioration because the asphalt coatings are not protected from the action of sunlight. If they are properly maintained (section VIII-1), they may render service equal to that of the mineral-surfaced roofings.

Smooth-surfaced roll roofings are marketed in several different weights per 108 sq ft, this being the amount necessary to cover one square of roof surface. The additional 8 sq ft is required to provide for lapping the sheets. The felt used as a base largely governs the finished weight of the roofing. Reference to table 2 will show that the weight of felt may vary considerably in roofings of different manufacture, particularly in the lighter weights of smooth-surfaced roofings.

The lighter weights of roll roofings (35- and 45-lb) are not recommended for any but the most temporary of structures. They are used advantageously as underlay materials for other roofing materials, such as slate, tile, and cement-asbestos shingles. The Underwriters' Laboratories, Inc. do not extend label service to smooth-surfaced roll roofings weighing less than 50 lb per 108 sq ft.

The standard grades of mineral-surfaced roll roofings are made on a felt base weighing not less than 48 lb per 480 sq ft. They have several advantages not possessed by the smooth-surfaced varieties. One of these is color. Originally these roofings were made in solid colors only, but at present they may be obtained in a number of colors and color combinations, either in solid areas or blended. Occasionally, granules of a different color are used to stencil patterns which simulate the appearance of shingles.

The mineral-surfacing granules protect the asphalt coating from the action of the elements and thus insure longer life. Another advantage is that these roofings are more fire-resistant than smooth-surfaced roofings. Because of their greater weight, they present a smoother appearance on a roof deck.

In order to relieve the monotony of the smooth, uniform appearance of mineral-surfaced roll roofings, one edge of the sheet is sometimes cut so that it will produce a regular pattern on a roof. Figures 5 and 6 illustrate two common types of designs. It will be observed that by

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increasing the lap of the sheet shown in figure 5 a regular hexagonal pattern will be produced. These are more expensive than roofings of the same weight per unit area but made with straight edges, because more material is required per unit area of roof. They usually have a greater lap than the roofings with straight edges, but lacking an unsurfaced lapping edge, the laps cannot be cemented as securely and the heads of the nails must be exposed.

Instructions for applying roll roofings are given in section VI–2, pages 26–28. Methods of application are illustrated in figures 1 to 6, inclusive.

Most roll roofings are essentially single-thickness coverings, that is, the greater part of the roof area on which they are laid is covered by but a single layer. The chief advantage of asphalt-prepared roll roofings is that, when applied properly, they present a continuous unbroken fabric over the entire roof deck. A disadvantage in any single-ply roof is its greater liability to puncture from accidental causes.

2. Asphalt Shingles

(a) *General Discussion*

The development of mineral-surfaced asphalt-prepared roofings marked a considerable advance over the smooth-surfaced roofings from the standpoint of appearance, yet they left much to be desired in this respect when considered as a roofing material for dwellings. The development of asphalt shingles followed as a natural consequence. The American public was thoroughly familiar with shingle-type roofs because of the wide use of wood shingles and slate. Metal shingles also preceded asphalt shingles, and certain designs of asphalt shingles were developed originally for metal shingles. Asphalt shingles provided a relief from the monotonous appearance of the roll roofings. In most cases they furnish better fire and weather resistance because of the multiple layers of fabric. Their development gave great impetus to the asphalt-prepared roofing industry, not only because shingle-type roofs require more material per unit area of roof but also because shingles are acceptable on many more structures, owing to their greater artistic value.

The first asphalt shingles were cut by hand from roll roofings. They were rectangular in shape, and were laid by the so-called "American" method, which is the same as that used in laying wood shingles and slate (figs. 7 and 8). Single-unit shingles are described as "individual" shingles, to distinguish them from multiple-unit shingles, commonly called "strip" shingles, which were developed later.

Asphalt shingles have been produced in a multiplicity of shapes, since manufacturers have vied with each other from the early days of the industry, to produce individualistic shingles with exclusive features.[7]

Space is not available to discuss all the different designs of asphalt shingles in detail. In general, variations in design have been intended to:

- Produce different patterns (rectangular, hexagonal, octagonal, circular, reversible shingles).
- Facilitate application (guide marks, tabs, etc).
- Give shingles a more massive appearance (shadings, thick butts).
- Secure the butts of shingles (metallic fasteners, slits, folds).
- Require less material per unit area.

Since asphalt shingles are fabricated products, they may be made in any shape or size within manufacturing limits. It was soon discovered that multiple-unit shingles offer certain economic advantages over individual shingles, chiefly because they may be applied more rapidly and accurately. They are composed of two, three, or four units joined together (figs. 12 to 16, inclusive). Since they are made up of a number of individual units, the patterns formed by strip shingles are substantially the same as those formed by individual shingles, and variations in the design of strip shingles have been made for the same purposes as those listed under individual shingles.

Three general types of shingles, from the standpoint of weight and thickness, are in

[7] Numerous references to the patent literature on asphalt-prepared roofings and shingles are given in Asphalts and Allied Substances, 4th ed. p. 1327–1396, by Herbert Abraham, published by D. Van Nostrand Co., Inc., New York, N. Y. (1937).

common use. They are (1) standard-weight, (2) heavy-weight, and (3) thick-butt. The standard- and heavy-weight shingles differ principally in the weight of the felt used as a base. The heavy-weight shingles are thicker and consequently more rigid, than those of standard weight.

Thick-butt shingles (figs. 14 and 15) are a comparatively recent development. They are made on felts of standard or lighter weight with the butts, for a distance slightly greater than the exposure, somewhat thicker than the remainder. This increased thickness is accomplished by applying additional layers of asphalt coating and granular surfacing materials. When the additional layers of coating and granules are applied to the exposed surface only, they are described as overlay shingles. Another type of thick-butt shingle is made by dipping the butts of the shingles into molten asphalt and embedding granules in this layer of asphalt, thus providing two layers of asphalt coating and two layers of granular surfacing material on the surface to be exposed to the weather, and two layers of asphalt and a layer of granules on the under side of the shingle. The dipping process seals the edges of the shingle that are to be exposed to the weather. This extra dipping and application of granules are done by hand so that shingles of this type are comparatively expensive.

The chief advantage claimed for thick-butt shingles is that they resist weathering better because of the extra layers of granules and coating on the exposure surface. The thicker butts, particularly of those with granules on both surfaces, give heaver shadow lines on the roof.

The multiplicity of designs and weights of individual and strip shingles that are available, and the various methods of laying both types of shingles, but particularly individual shingles, produce a picture that is confusing to the average home owner.

Some of the more important factors that should be considered when purchasing asphalt shingles are defined and explained in the succeeding section. These factors are illustrated by drawings of sections of roofs laid with some of the common types of shingles, figures 7 to 16.

These factors are coverage, headlap, sidelap, exposure, and weight per unit area of roofing material, and, more particularly, per unit area of finished roof. These factors are applicable to all kinds of roofing materials that are applied in the form of shingles. Appearance is an important factor also, but it will not be discussed under this heading because it is entirely a matter of personal preference.

(b) Coverage

The term "coverage", used in connection with roofs, is more easily explained than defined. Asphalt-prepared roll roofings are described as "single-coverage" roofings because they provide but a single layer of material over the greater part of the roof area. Shingles invariably are small units laid so that they overlap shingles in the course, or courses, below, and in certain cases, shingles adjacent to them. Roofs constructed of shingles therefore are made up of areas covered by one to four layers, or plies, of material, depending on the size and shape of the shingles and the method by which they are applied. These areas, designated as one-, two-, three-, or four-ply areas, and expressed as percentages of the whole roof area, constitute the distribution of coverage, or more simply, the coverage of the shingles.

Calculation of coverage must be made on the basis of a unit which is repeated over the entire surface of the roof. For individual shingles laid by the American method, figures 7 and 8, the simplest unit is one exposed tab, or butt, and one space between two exposed tabs. The coverage diagram in the lower right-hand corner of figures 7 to 16, inclusive, represents the repeating unit for each design of shingle illustrated and shows graphically the distribution of coverage.

Knowing the extent of the areas covered by the different numbers of layers, it is a simple matter to calculate the total area of fabric required per square of finished roof. Thus individual shingles 9 by 12¾ in. in size, laid as illustrated in figure 7, furnish approximately the following coverage: Four-ply, 17 percent; three-ply, 73 percent; two-ply, 6 percent; one-ply, 4 percent; or, in one square of finished roof 68 sq ft of fabric in the four-ply area; 219 sq ft in the three-ply; 12 sq ft in the two-ply; and 4 sq ft in the one-ply—a total of 303 sq ft.

The same shingles laid by the so-called wide-space method (illustrated in fig. 9) furnish the following distribution: Four-ply area, 4 percent; three-ply, 16 percent; two-ply, 48 percent; and one-ply, 32 percent; or, in one square of finished roof 16 sq ft in the four-ply area; 48 sq ft in the three-ply; 96 sq ft in the two-ply; and 32 sq ft in the one-ply—a total of 192 sq ft. In each case, the number of shingles required for one square of finished roof is obtained by dividing the area of one shingle into the total area of roofing material required for one square.

It is practically impossible to determine the coverage of the different types of shingles by calculations based on visual inspection. A simple, practical method is to cut miniature shingles, drawn to proper scale, from transparent paper or tracing cloth, fasten them to a transparent background, and view them by reflected light. The number of layers of fabric at any point will be immediately apparent.

The American method of laying, illustrated in figures 7 and 8, furnishes the best coverage of any of the methods utilizing individual shingles. The method shown in figure 8, with the first and fourth courses of shingles in line, provides a slightly better distribution of coverage than that shown in figure 7, with alternate courses in line. Both of these methods are entirely satisfactory.

The wide-space method, illustrated in figure 9, requires the same shingles as the American method, but spaces them at much greater distances, usually 6 in. for a 9-in. shingle. Consequently but 240 shingles, 9- by 12¾-in., are required per square when laid by this method, as compared with 380 when laid by the American method. Stated differently, the American method requires 58 percent more fabric per square. Also, almost one-third of the area of roofs laid by the wide-space method is covered by but a single layer of fabric. This method has been used principally for reroofing and is not widely used at present.

The hexagonal, or French, and the Dutch-lap methods of laying individual shingles, figures 10 and 11, are little better than roll roofings from the standpoint of coverage. These methods are not recommended by manufacturers for new roofs, but many have been used in this manner. They have been and are being used widely for reroofing.

When laid, strip shingles furnish practically the same patterns as individual shingles, and may be considered as individual shingles that have not been separated. The portions that are cut away to form the tabs, commonly called "cut-outs", extend only the length of the exposed tab, whereas in individual shingles the corresponding space extends the entire length of the shingle. Square-tab strip shingles with tabs the same width as individual shingles, and of the same length, therefore furnish slightly better coverage than the latter. The patterns shown by figures 7 and 12 are almost identical, yet the coverage of the strip shingle illustrated in figure 12 is somewhat better than that of the shingles shown in figure 7, although the latter are ¼ in. longer. This should not be construed as a blanket indorsement of strip shingles over individual ones laid by the American method, because other factors must be considered. Shingles laid as illustrated in figures 7 and 8 require 760 nails per square, whereas those shown in figure 12 normally are laid with 500 nails. The individual shingles are fastened more securely than the strip shingles, but the latter may be applied more cheaply because they require fewer nails and less labor. Individual shingles, being small units, each nailed separately, do not show as readily as do the larger-unit strips any changes that take place in the roof deck, such as are caused by warping of unseasoned sheathing boards.

Individual shingles are frequently provided with self-spacing features, consisting of projections on one side and corresponding recesses on the other. The coverage of such shingles is the same as that of strip shingles which are of the same length and which are exposed the same distance.

The relation of coverage to waterproofness is obvious. Shingles that provide approximately three layers of fabric over the entire surface of a roof may be weathered so badly that the granular surfacing material and asphalt coating have disappeared entirely from the exposed surface, yet the roof will not leak because of the layers of unweathered fabric beneath.

Roofers state frequently that individual or

strip shingles that provide but single coverage over a large proportion of the roof area are entirely satisfactory for reroofing purposes over weathered wood or asphalt shingles. They may render satisfactory service when the roof is new, but, actually, shingles that furnish single coverage are no more durable than the single layer of fabric. Numerous observations in the field have shown that the oldest roofs are almost invariably of shingles that furnish the best coverage. Most complaints of unsatisfactory waterproofness arise from shingles that provide poor coverage.

Shingles that furnish the best coverage have the highest first cost, because they require more material per unit area of roof and more labor to apply them. The better the coverage, the greater the insulation effect of shingles, although it is true that the insulation value of the best asphalt shingles, like that of most roofing materials, is very slight when compared with that of materials that are used regularly for heat-insulation purposes.

The fire resistance of multiple-layered asphalt-prepared roofings is greater than that of single-coverage roofings.

(c) *Headlap*

Headlap, in shingle-type roofs, is usually defined as the distance a shingle in any course overlaps a shingle in the second course below it. However, with shingles laid by the Dutch-lap method, figure 11, where no shingle overlaps a shingle in the second course below, the headlap is taken as the distance a shingle overlaps one in the next course below. A more proper definition of headlap is the distance water must travel upward from the outside to the inside of a roof, assuming there are no breaks in the fabric. This latter definition emphasizes the importance of headlap to the waterproofness of a shingle roof.

The headlap of individual shingles laid by the American method, and of strip shingles, may be determined by subtracting twice the distance a shingle is exposed from its full length.[8]

For example, the shingles shown in figures 7 and 8 are 12¾ in. in length and are exposed 4 in.; the headlap is therefore 4¾ in. Those in figure 16 are 11⅓ in. in length and are exposed 4⅔ in.; the headlap in this case is but 2 in. In figures 13 and 14 the headlap is also 2 in. The headlap of the shingles illustrated in figures 7 to 16 is designated in each case as the distance *ab*.

An important consideration in determining the waterproofness of shingles of different design and laid by different methods is the lateral distance that may be said to be vulnerable to deficiencies in headlap. Unfortunately, in most shingles where this distance is comparatively great, the headlap is reduced to a minimum. In individual shingles laid by the American method this lateral distance is the width of the spacing between the shingles. In square-tab strip shingles it is the width of the sections that are cut out to form the tabs, usually ½ or ¾ in. in standard-weight shingles, and ¾ or 1 in. in heavyweight shingles. In strip shingles that provide a hexagonal pattern when laid, this distance is greater than for the square-tab shingles. For the 11⅓- by 36-in. shingles shown in figure 16, it is 4 in. This distance is greatest in shingles laid by the Dutch-lap method, it being 10 in. for these shown in figure 11.

(d) *Sidelap*

Sidelap is defined as the horizontal distance one individual shingle overlaps another in the same course. This item is important mainly with shingles laid by the Dutch-lap, hexagonal, and wide-space methods. The sidelap is designated as the distance *ef* in figure 9 to 11, inclusive. A study of these figures will show the relation of sidelap to waterproofness. Obviously, as the sidelap is increased, coverage is increased.

(e) *Exposure*

The exposure of a shingle is defined as the maximum distance, measured on the length of the shingle, that is exposed to the weather, disregarding the space between individual shingles and the cut-out sections of square-tab strip shingles. In figures 7 to 16, inclusive, the exposure is designated as the distance *cd*. The exposure of shingles is of primary importance from several standpoints. For a given shingle

[8] The use of the terms "length" and "width" in connection with individual and strip shingles may be somewhat confusing. In this discussion, length is understood to mean the vertical dimension of a shingle when laid on a roof. In individual shingles, except those laid by the Dutch-lap method, this is greater than the horizontal dimension; in strip shingles and individual shingles laid by the Dutch-lap method, it is less than the horizontal dimension.

the headlap, coverage, and exposure are interdependent; as the exposure is increased, the headlap and coverage are decreased correspondingly. As the exposure is increased, the possibility of damage from winds of high intensity is increased.

Individual shingles are furnished frequently with guide marks to enable the roofer to determine the correct exposure. The self-spacing features mentioned previously also accomplish this purpose. The exposure of strip shingles is determined by the length of the portions that are cut away to form the tabs. This fact greatly facilitates the laying of strip shingles.

Individual shingles that are laid by the Dutch-lap or hexagonal methods, where the greater part of the area of each shingle is exposed to the weather, are usually furnished with some fastening or locking device to hold them in place. Such devices are also used frequently with strip shingles that have large exposures, particularly with those that give hexagonal patterns when laid.

(f) *Weight*

(1) *Per unit area of shingle.*

The weight per unit area of asphalt shingles, as of prepared roll roofings, is governed largely by the weight of the felt used as a base. (See table 3.) Felts weighing 48 to 53 lb per 480 sq ft (Nos. 48 to 53) are used commonly for standard-weight shingles. Felts used for heavy-weight shingles may range from 60 to 80 lb per 480 sq ft (Nos. 60 to 80).

The so-called thick-butt shingles are not uniform in weight throughout, the section that is to be exposed being covered with an additional layer of asphalt and surfacing granules. These shingles are usually made on a No. 48 felt. The weight per unit area of the thick-butt section should be not less than 100 lb per 108 sq ft.

Table 3 shows the composition of representative samples of standard-weight asphalt shingles.

(2) *Per unit area of roof.*

The weight per unit area (square) of roofs covered with asphalt shingles depends on the weight per unit area of the shingles, and the coverage. The common types of shingles on the market range from 125 to 325 lb per square when laid and some have been marketed that weighed as much as 375 lb per square.

Table 4 lists the weight per square of finished roof for the types of shingles used most generally. These are average weights, which will vary slightly in shingles of the same dimensions from different manufacturers.

The different types of shingles have been classified roughly in table 4 by weight per square of finished roof. In general, the shingles that furnish the greatest weight provide the best coverage, headlap, etc., and may be considered best for durability, waterproofness, and fire resistance.

Several types of asphalt shingles provide practically the same weight per square of finished roof. These are as follows: Individual shingles, American method, standard weight, 250 lb; square-butt strip shingles, 12½- by 36-in., standard weight, 265 lb; square-butt strip shingles, 12- by 36-in., heavy weight, 257 lb; and square-butt strip shingles, 15- by 36-in., overlay type, 254 lb. An intercomparison of some of the features exhibited by these shingles may be helpful in comparing other types of shingles. These will be designated as follows:

(*a*) Individual shingles, 8- or 9- by 12¾-in., American method. (Fig. 7.)

(*b*) Strip shingles, 12½- by 36-in. (Fig. 12.)

(*c*) Strip shingles, 12- by 36-in. (Not illustrated.)

(*d*) Strip shingles (overlay), 15- by 36-in. (Fig. 15.)

Coverage.—There is little difference in coverage between the *a*, *b*, and *d* shingles, each requiring about the same area of fabric per square. The *c* shingles, although of approximately the same weight as the *a*, *b*, and *d* shingles, provide poorer coverage. The area covered by but a single thickness (single-coverage area) with the *c* shingles is so small as to be almost negligible. The *a*, *b*, and *d* shingles furnish not less than double coverage at any point, however, and the greater part of the roof is covered with three layers of fabric with those shingles, whereas with the *c* shingles but 37 percent is covered with three layers.

Headlap.—The *a*, *b*, and *d* shingles with headlaps of 4¾, 4½ and 5 in., respectively, are definitely superior in this respect to the *c* shingles, which have but a 2-in. headlap.

TABLE 4.—*Individual and strip shingles*

Type	Method of application	Pattern	Grade	Size	Exposure	Head-lap	Side-lap	Width of spacing or cutouts	Coverage: 1-ply area	Coverage: 2-ply area	Coverage: 3-ply area	Coverage: 4-ply area	Weight per square applied	Number of shingles per square	Total area of roofing per square	Number of nails per square	Cost per square applied [a]: Northeastern States: Minimum	Northeastern States: Maximum	Northeastern States: Average	Southeastern States: Minimum	Southeastern States: Maximum	Southeastern States: Average
325 POUNDS PER SQUARE																						
				In.	*In.*	*In.*	*In.*	*In.*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Lb*		*Ft²*							
Individual	American [b]	Square-tab	Heavy	12 by 16	5	6		¾		15	68	17	325	226	302	452	$12.85	$20.00	$15.50	$9.50	$14.50	$10.65
Do	do [b]	do	do	10 by 16	5	6		¾		18	66	16	325	268	298	536						
240 TO 270 POUNDS PER SQUARE																						
Individual	American [b]	Square-tab	Standard	9 by 12¾	4	4¾		½		14	70	16	250	379	302	758	$10.50	$16.50	$13.70	$8.25	$13.50	$9.45
Do	do [b]	do	do	9 by 12¾	4	4¾		¾		20	65	15	244	370	295	740						
Do	do [c]	do	do	9 by 12¾	4	4¾		½	4	6	73	17	250	380	302	760						
Do	do [b]	do	do	8 by 12¾	4	4¾		½		15	69	16	250	424	300	848						
Strip		do	do	12¼ by 36	4	4½		½		5	83	12	265	100	307	500	10.30	16.00	13.35	8.25	10.40	9.00
Do		do	do	12½ by 36	4	4½		¾		7	81	12	265	100	305	500						
Do		do	Heavy	12 by 36	5	2		¾	4	59	37		257	80	234	320						
Do		do	Overlay	15 by 36	5	5		¾		6	94		254	80	296	320						
200 TO 230 POUNDS PER SQUARE																						
Strip		Square-tab	Standard	10 by 36	4	2		½	3	50	47		210	100	244	500						
Do		do	do	10 by 36	4	2		¾	4	50	46		210	100	242	500						
Do		do	Overlay	12 by 36	5	2		¾	4	59	37		210	80	234	320	$9.50	$14.00	$11.55	$6.75	$9.10	$7.95
Do		do	Double-dipped	12 by 36	5	2		¾	4	59	37		230	80	234	320						
Do		Hexagonal	Standard	12½ by 36	4	4½			13	60	27		227	100	263	400						
160 TO 185 POUNDS PER SQUARE																						
Strip		Hexagonal	Standard	11⅓ by 36	4⅔	2			22	63	15		167	86	193	344	$8.50	$12.00	$9.75	$5.25	$7.15	$6.35
Do		do	do	12⅓ by 36	4⅔	3			13	60	27		185	86	214	344						
Individual	Dutch-lap		Heavy	12 by 16	10	2	3		62	29	9		162	111	148	222						
Do	Wide-space		Standard	9 by 12¾		4¾	1½	6	32	48	16	4	165	240	192	480						
Do	do		do	9 by 16		6	1½	6	32	48	16	4	165	192	192	384						
125 to 150 POUNDS PER SQUARE																						
Individual	Dutch-lap		Standard	13 by 18		3	3		56	32	12		134	96	156	192	$7.50	$12.00	$9.70	$5.25	$6.90	$5.85
Do	Hexagonal	Hexagonal	do	12 by 12		2½	2½		47	34	19		147	172	172	344						
Do	do	do	do	14 by 14		2½	2½		57	31	12		134	115	155	230						
Do	do	do	do	16 by 16		2½	2½		63	28	9		125	82	146	164	7.50	12.00	9.60	5.25	6.80	5.90

[a] See explanation, p. 14. [b] First and fourth courses in line. [c] Alternate courses in line.

Exposure.—The *a* and *b* shingles are intended to be laid with a 4-in. exposure, the *c* and *d* with a 5-in. exposure. There is probably little to choose between the 4- and 5-in. exposures in these cases. The *c* and *d* shingles are more rigid than the *a* and *b* shingles because of the greater thickness of the exposed areas, and therefore would probably not suffer more from winds of average intensity.

Weight.—As noted previously, the weights per square of these shingles are practically the same, so that one has little, if any, advantage over another in this respect. The *a*, *b*, and *d* shingles probably furnish greater weights of coating asphalt than the *c* shingles because of the greater area. The *c* shingles, by the same reasoning, probably contain more felt and saturating asphalt than the other shingles. However, the *a*, *b*, and *d* shingles furnish a better distribution of weight, generally, than the *c* shingles. This is particularly true of the *a* and *b* shingles.

(*g*) *Cost*

Representatives of the Home Owners' Loan Corporation in the cities listed below furnished, in 1938, the cost figures listed in table 4.

Northeastern States	*Southeastern States*
Wilmington, Del.	Greensboro, N. C.
Philadelphia, Pa.	Columbia, S. C.
New Haven, Conn.	Savannah, Ga.
Boston, Mass.	Atlanta, Ga.
Manchester, N. H.	Jacksonville, Fla.
Portland, Maine	Birmingham, Ala.
Rutland, Vt.	Knoxville, Tenn.

The cost of application per square (100 sq ft of roof surface) is included in these figures. The range of costs in each section is shown in the columns marked "minimum" and "maximum." The minimum and maximum costs were distributed among the different cities in each group and were not confined to a particular one. The average cost shown is the average for all the cities in each group.

The cost figures in table 4 are presented mainly for purposes of comparison rather than as a guide to current costs. They are valuable in that they show the range of costs of shingles of different weight, coverage, etc.

VI. METHODS OF APPLICATION [9]

Figures 1 to 20, inclusive, illustrate methods of applying asphalt-prepared roll roofings and shingles, also recommended practices for the construction of valleys and flashings, and finishing hips and ridges. Only the shingles used most commonly are illustrated. In general, the purpose has been to show a variety of satisfactory practices rather than to indicate that a particular method must be used with a particular type of shingle. For example, some illustrations show a metal drip edge at the eaves, while others use wood shingles for this purpose. Either is considered satisfactory. Some illustrations show the use of underlay materials, and in others they are omitted. The conditions under which underlay materials may be omitted are indicated in the text.

1. General Discussion

Certain basic principles apply to the application of all types of asphalt-prepared roofings. These will be considered first, followed by some of the more important details that should be followed in the application of particular types of roofing.

(*a*) *Weather Conditions*

Asphalt-prepared roofings are best applied during clear, mild weather. Extremes of temperature should be avoided whenever possible. It is a poor practice to walk on asphalt-prepared roofings at any time, but they should never be walked on during extremely hot or cold weather. When the outside temperature is high (90° F or higher), the asphalt coatings and saturant will be relatively soft and any pressure on the roofing may damage it. When the roofing is cold, the coating and saturant are relatively hard and brittle, so that any sudden bending may cause cracks. If the outside temperature is below 60° F, the roofing should be stored in a warm room for 24 hours before application. Roll roofings should be unrolled slowly and carefully. Asphalt-prepared roofings, particu-

[9] The material in this section is taken principally from instructions prepared by manufacturers of asphalt-prepared roofings. These instructions, which are always furnished with the roofings, generally give clear, concise directions, which, if followed, would prevent many of the difficulties that are encountered with these materials. Unfortunately, the instructions are too often disregarded.

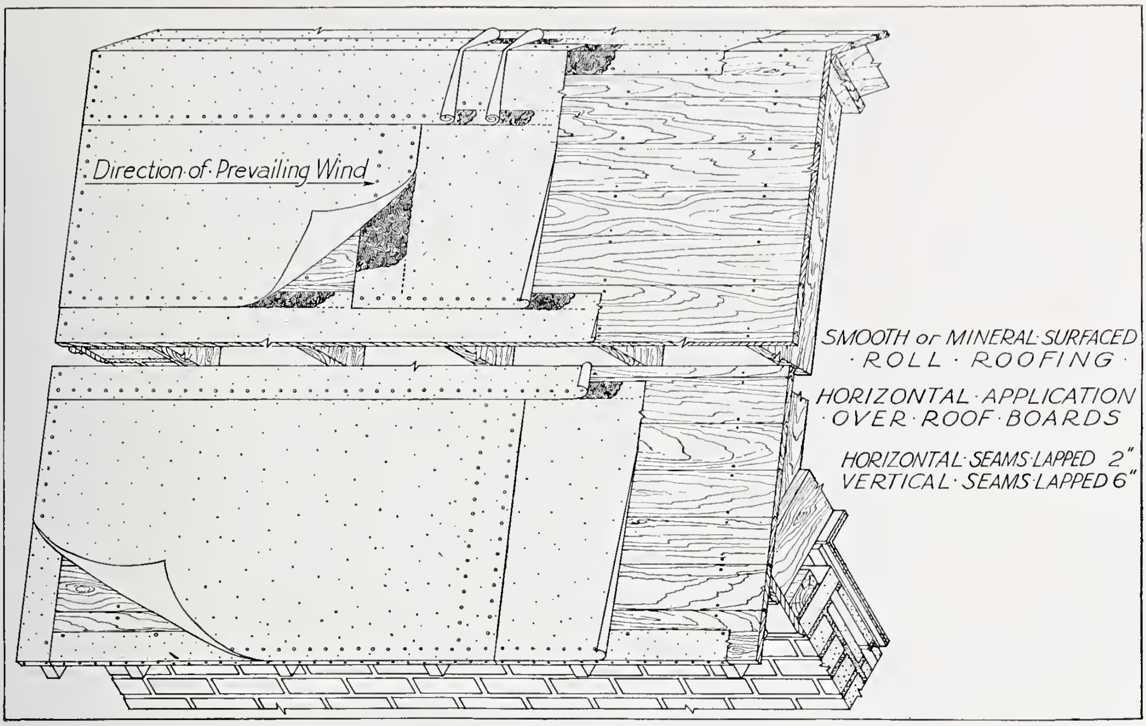

FIGURE 1.

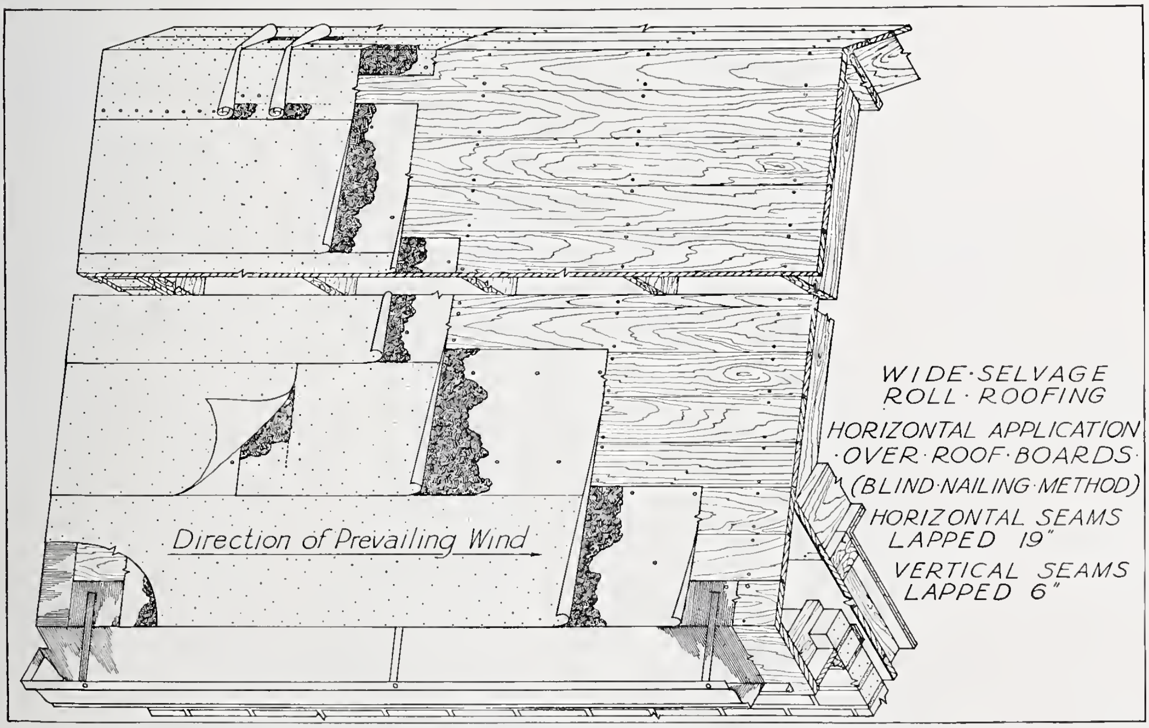

FIGURE 2.

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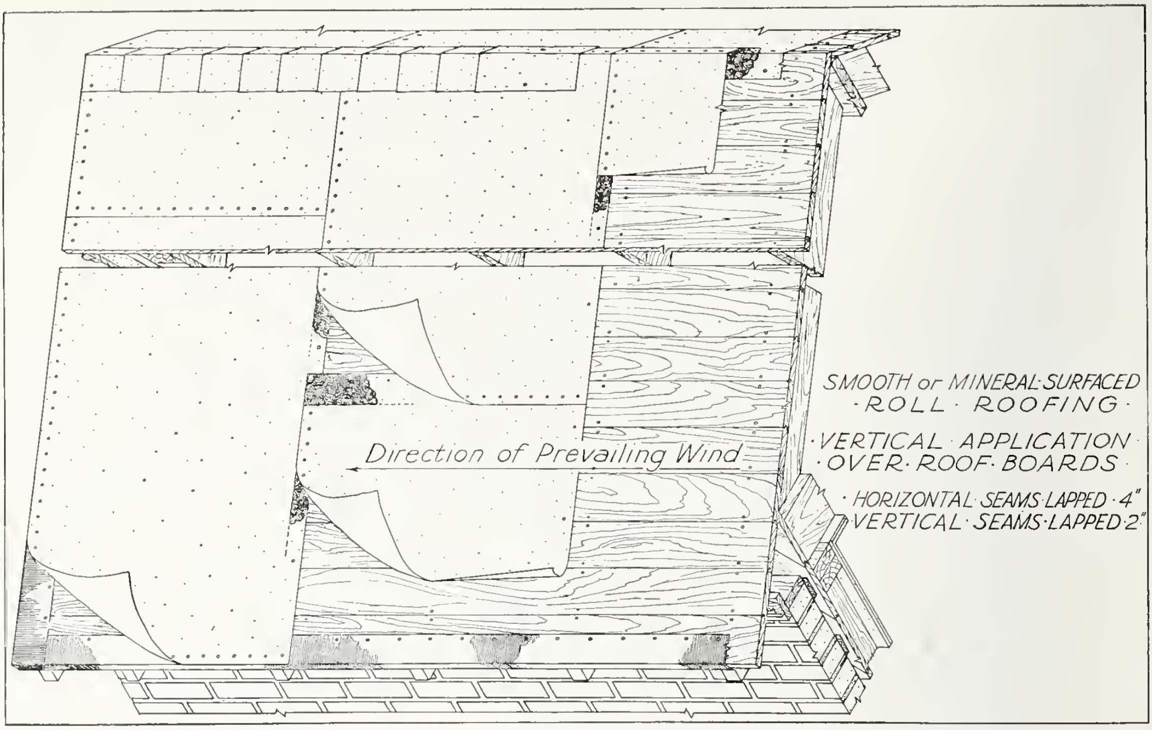


FIGURE 3.

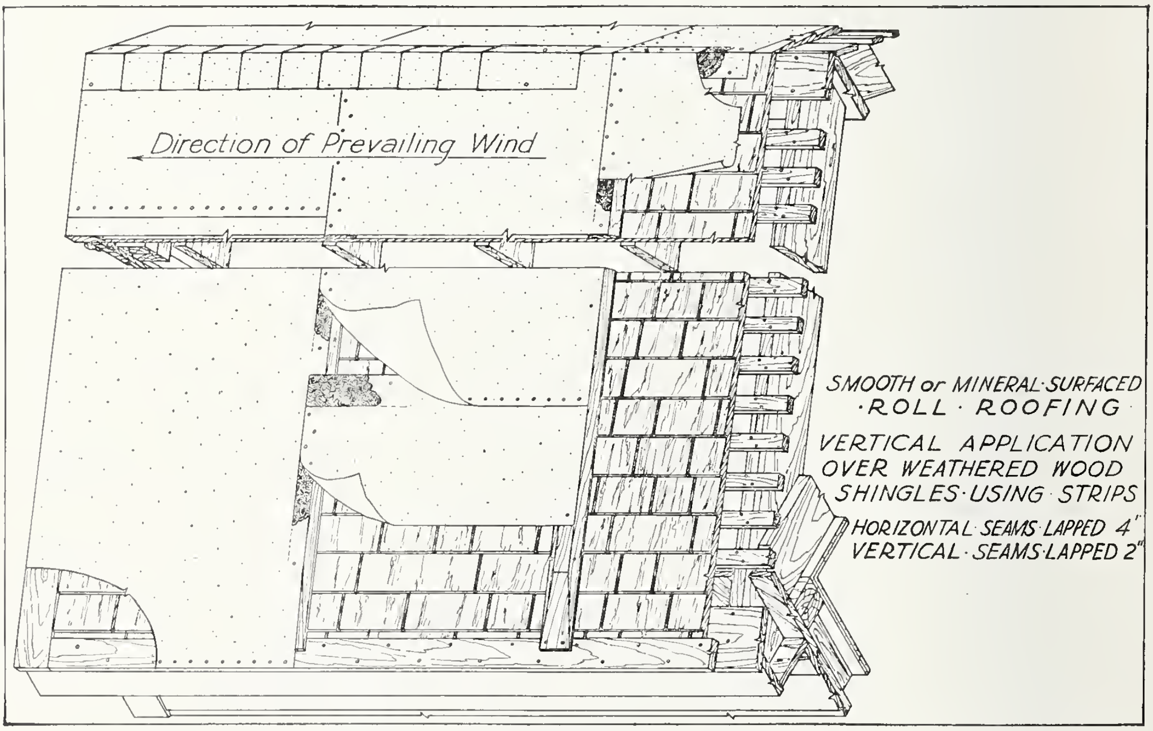
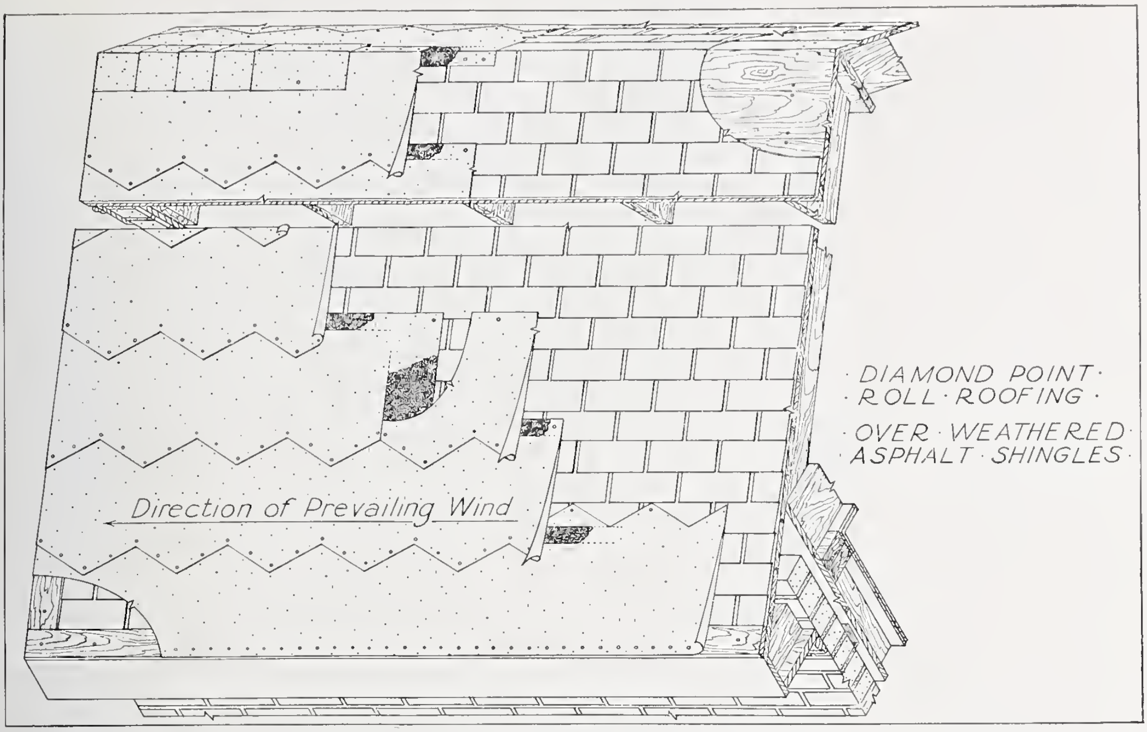


FIGURE 4.



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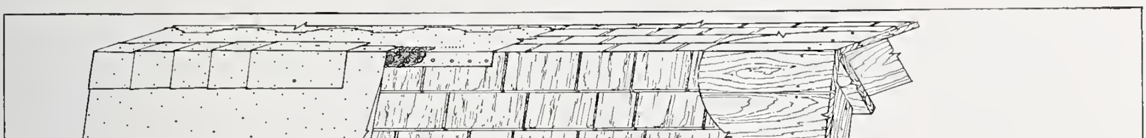

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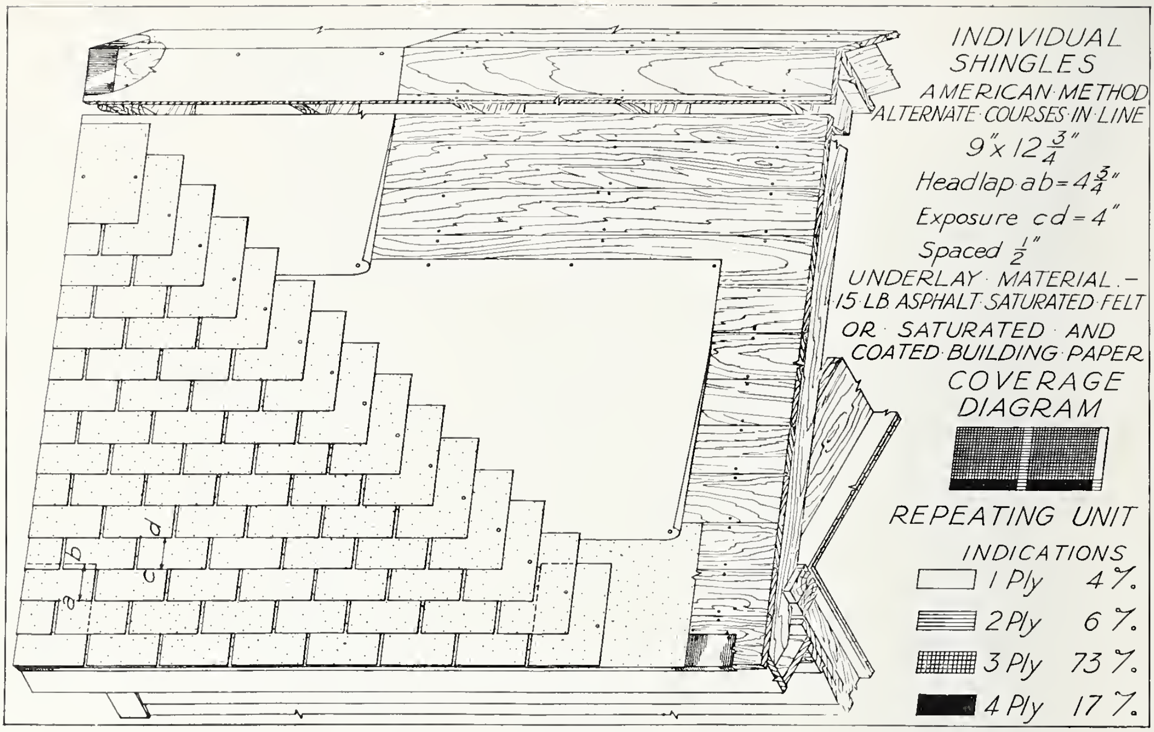

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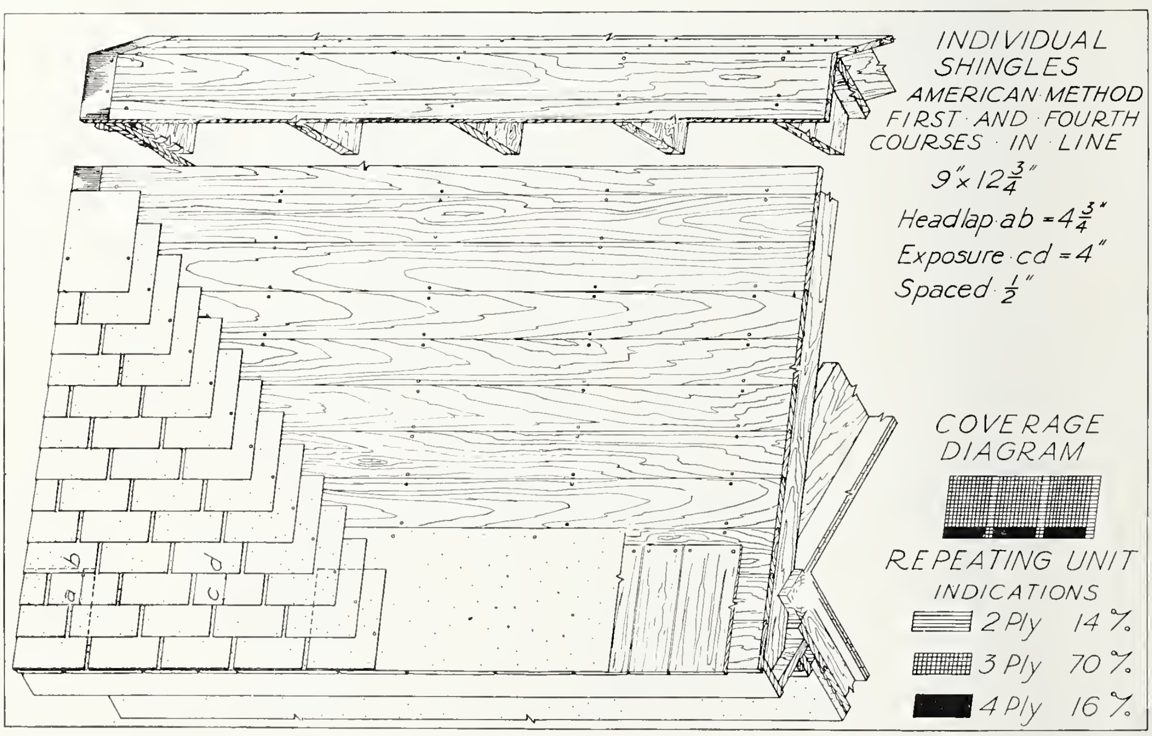

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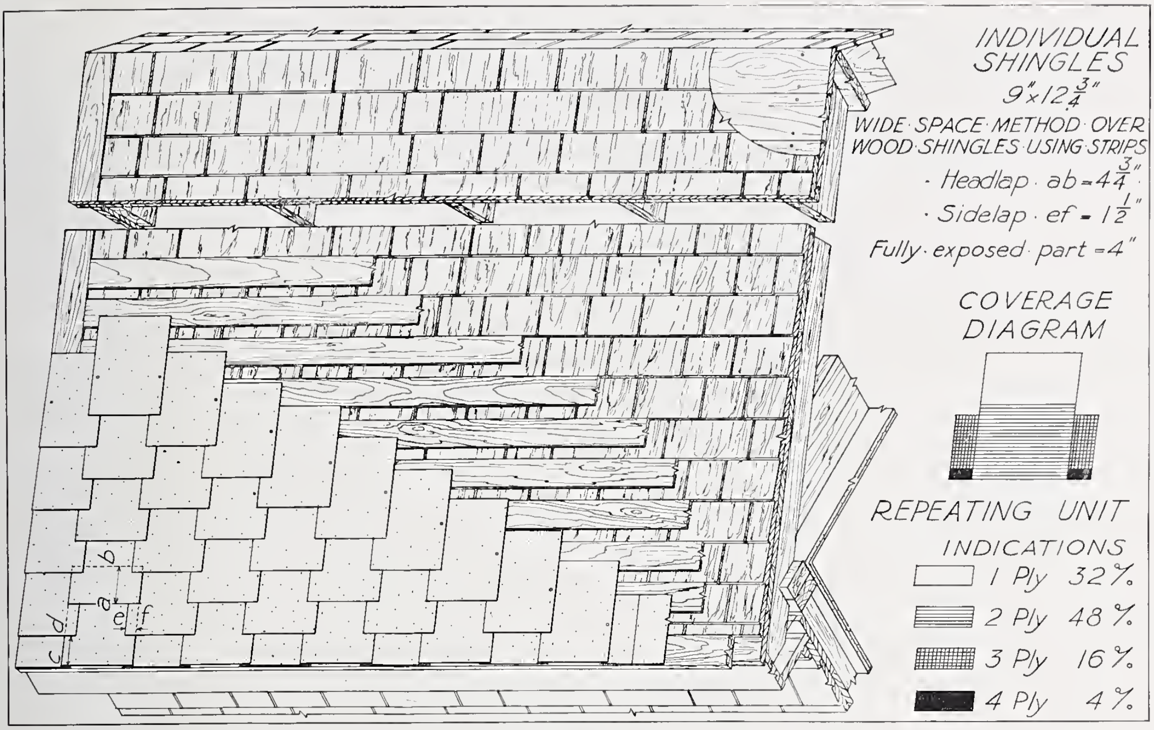

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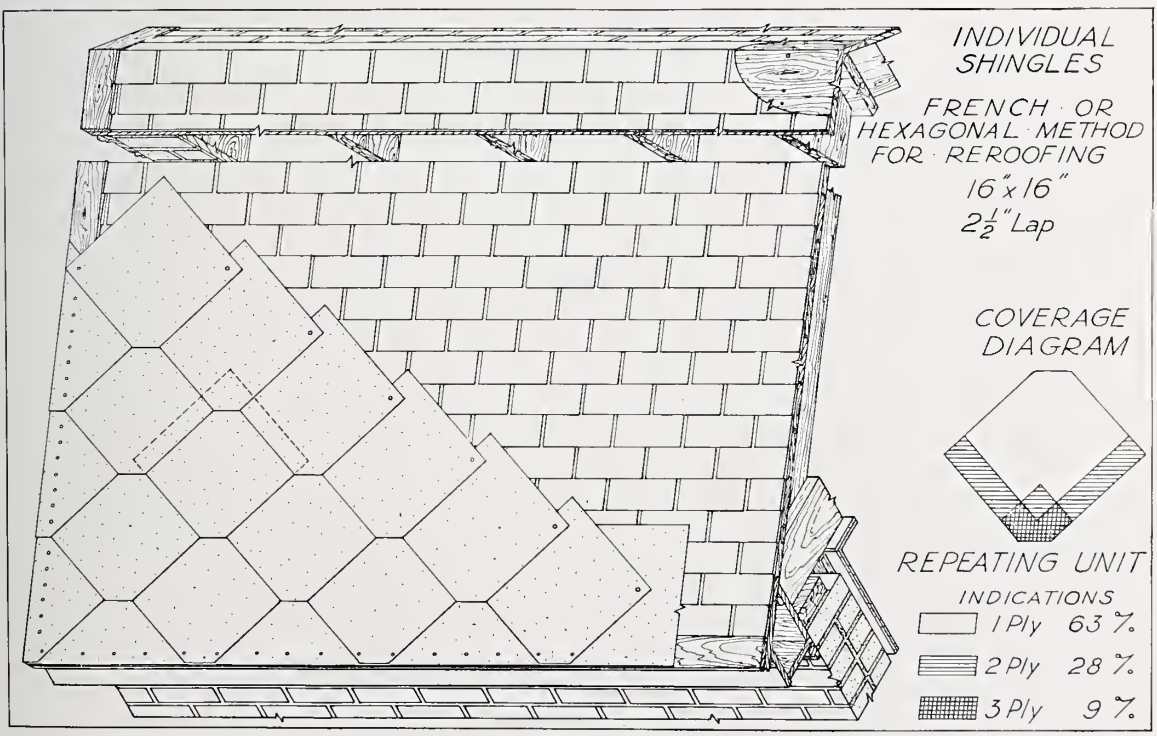


Figure 10.

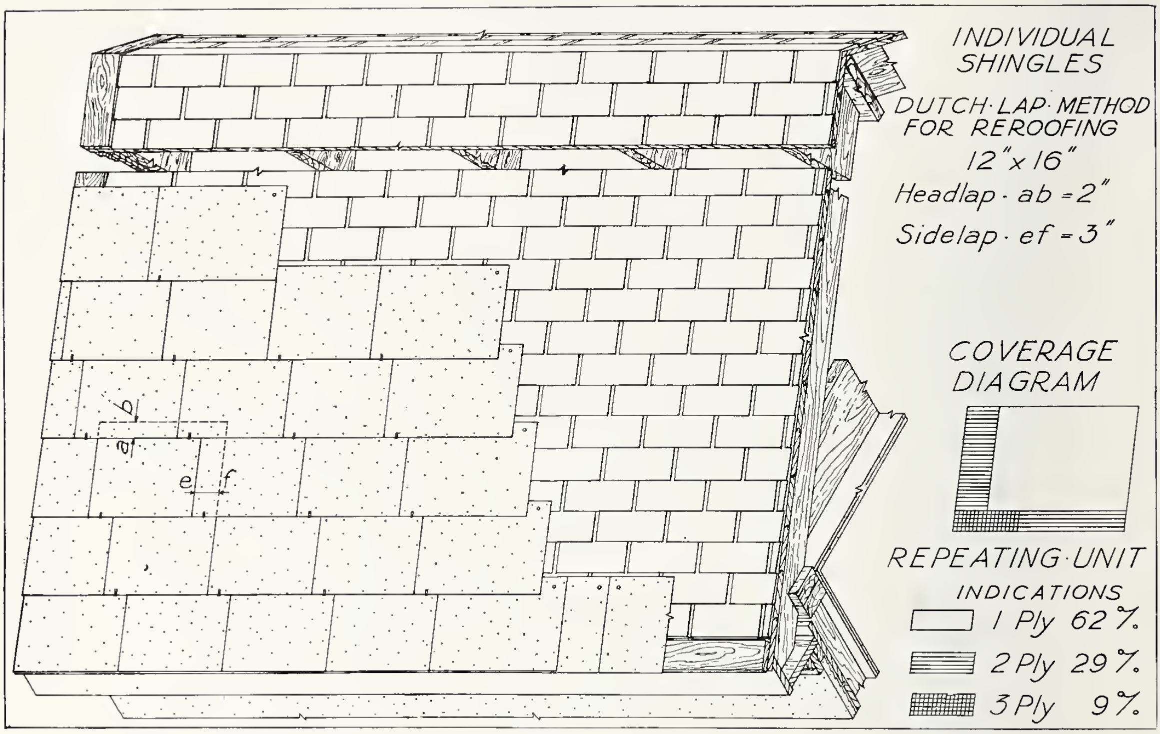
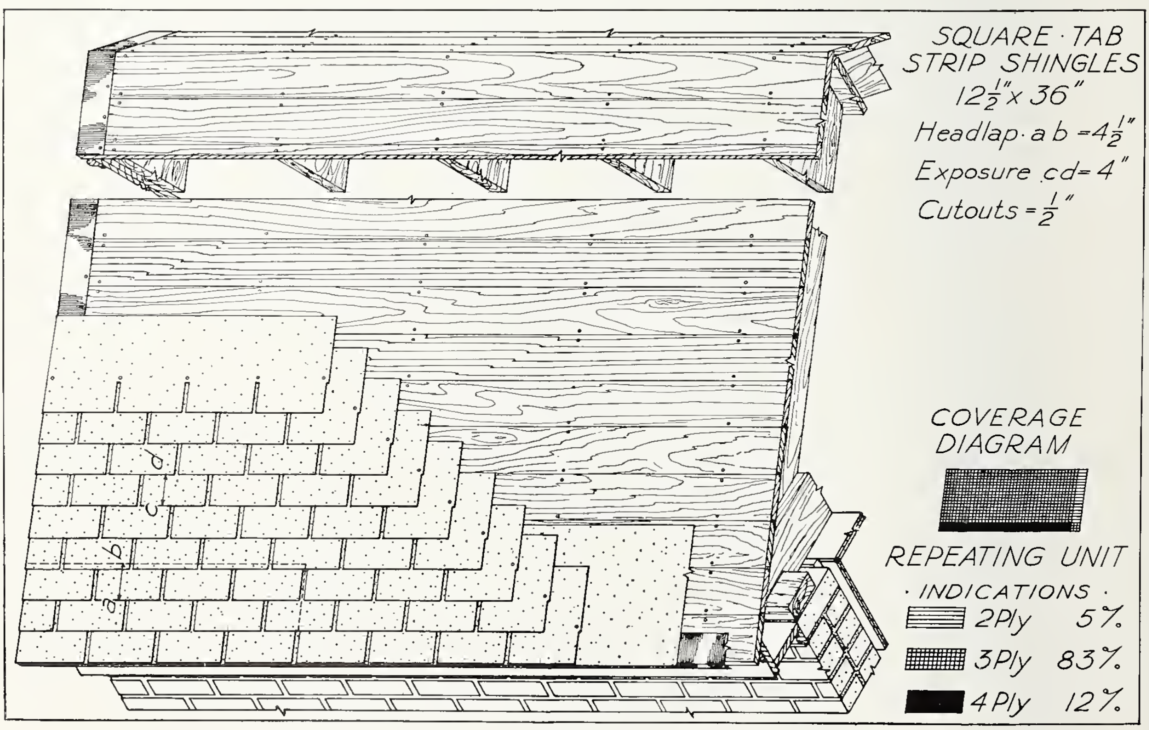


FIGURE 11.



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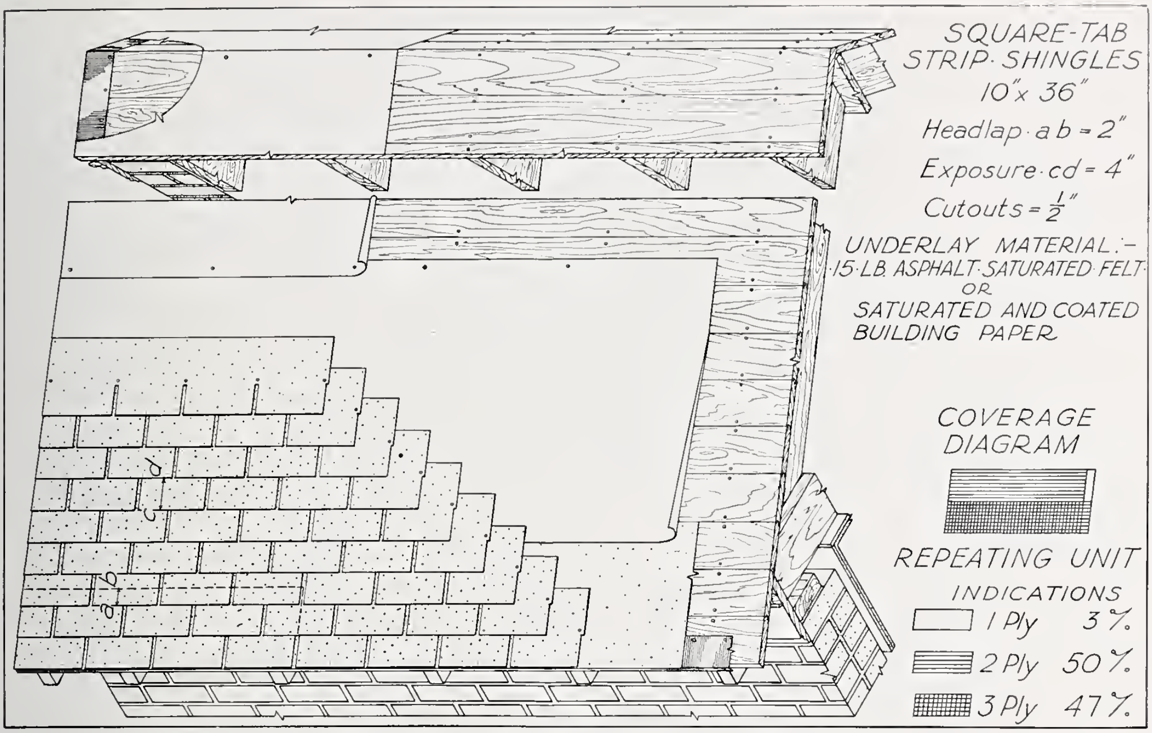

Figure 13.

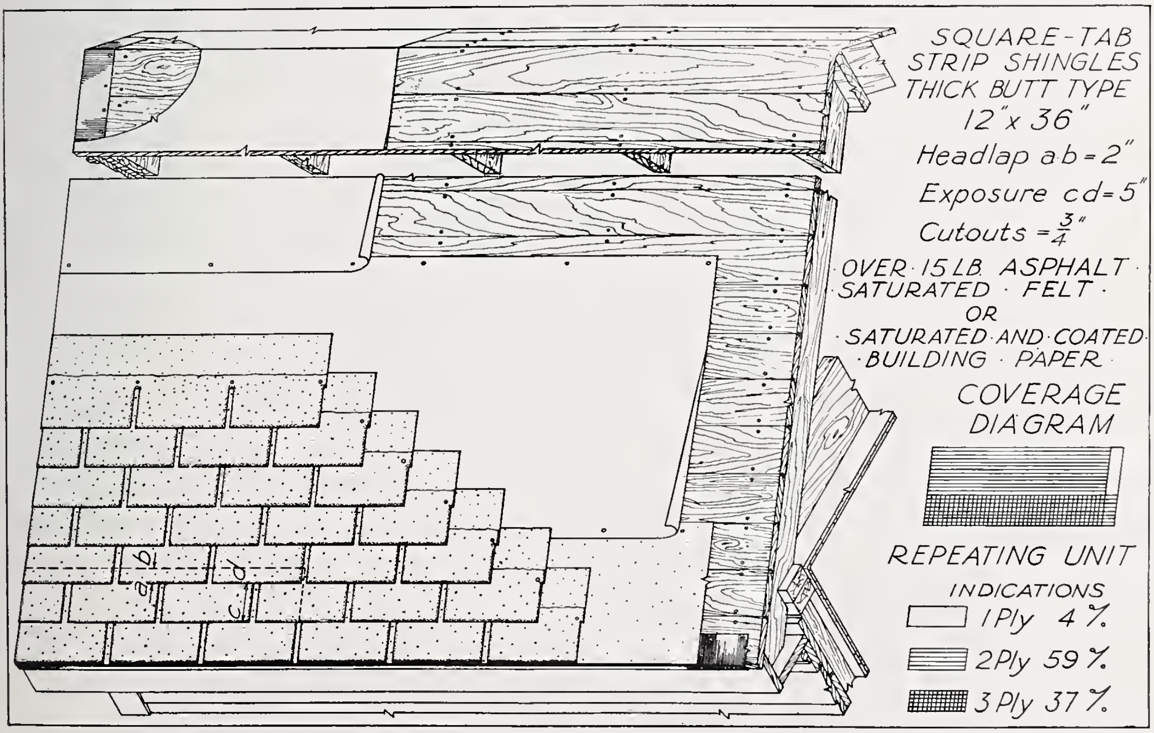

Figure 14.

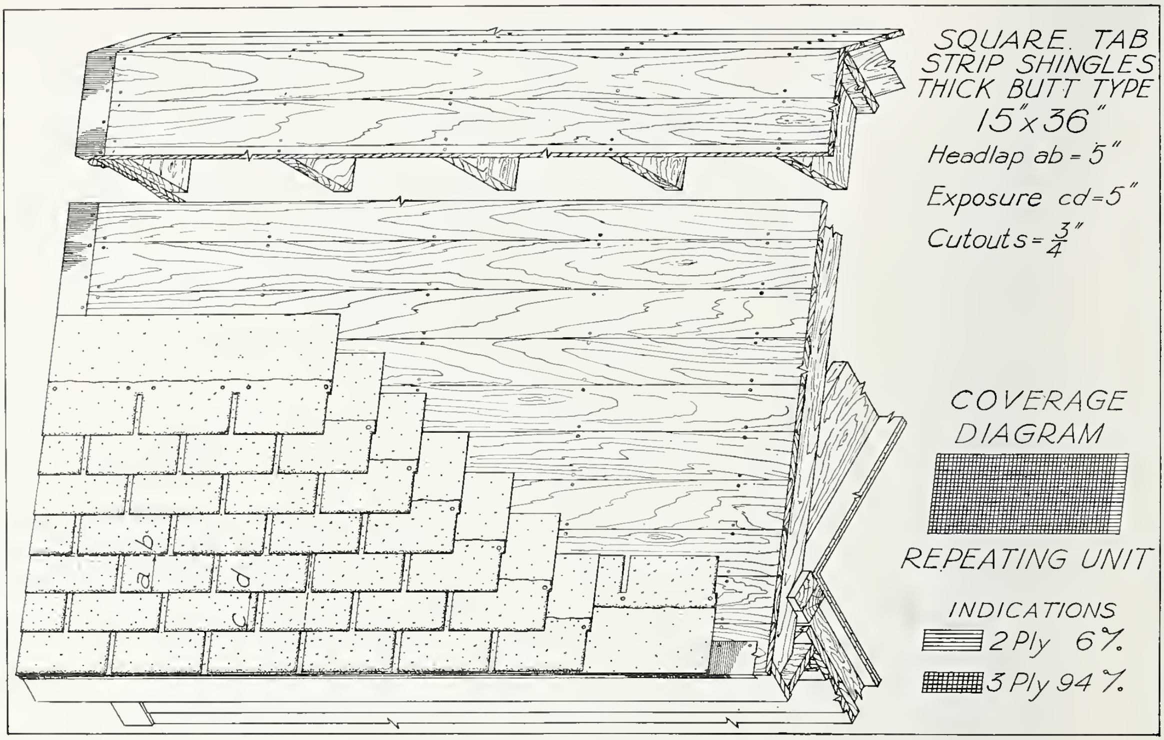

Figure 15.

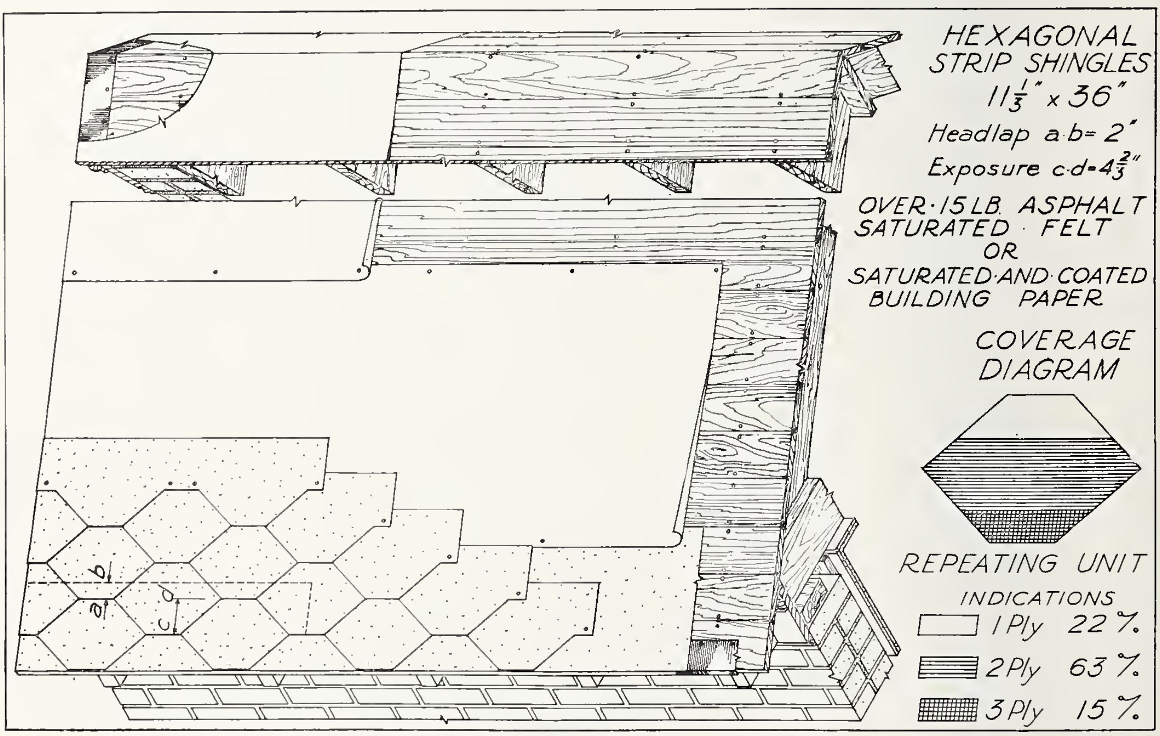

Figure 16.

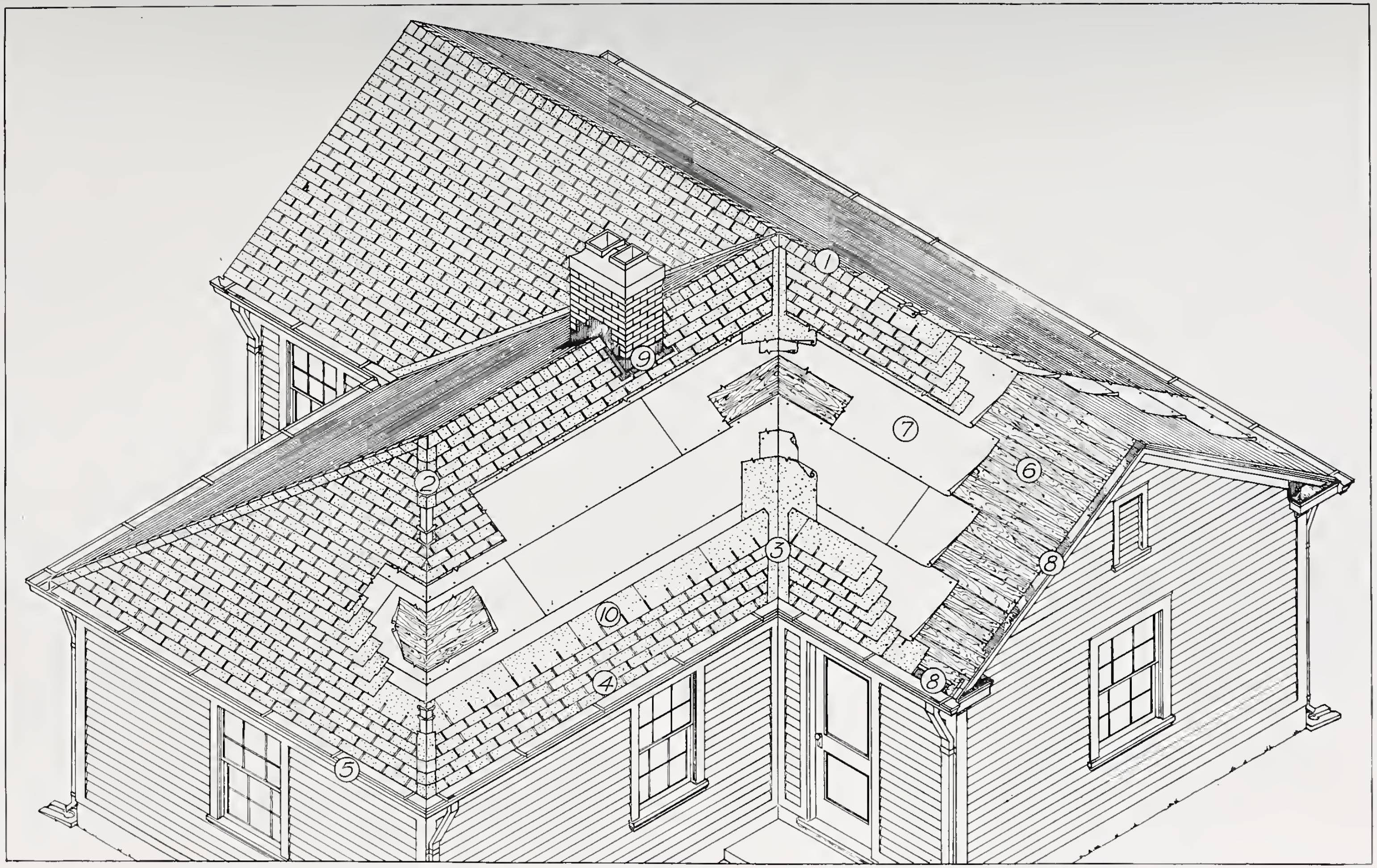

FIGURE 17.

1. Ridge.
2. Hip.
3. Valley.
4. Eaves.
5. Eaves trough or gutter.
6. Sheathing boards.
7. Underlay material.
8. Metal edging strips.
9. Metal chimney flashing.
10. Asphalt strip shingles.

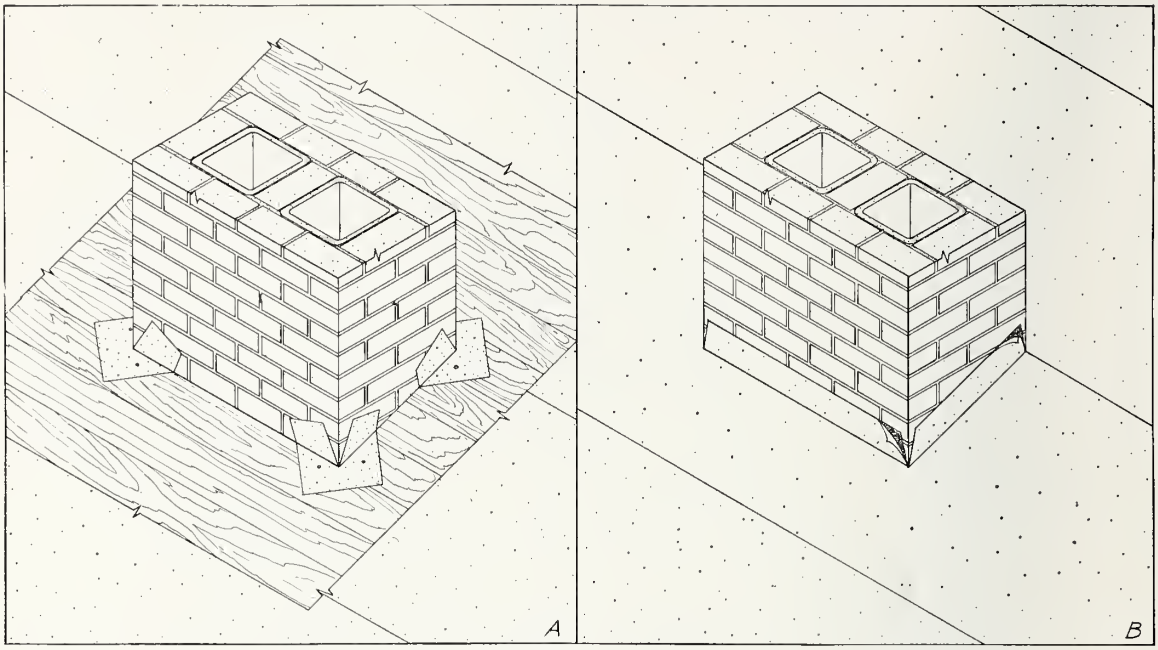

FIGURE 18.

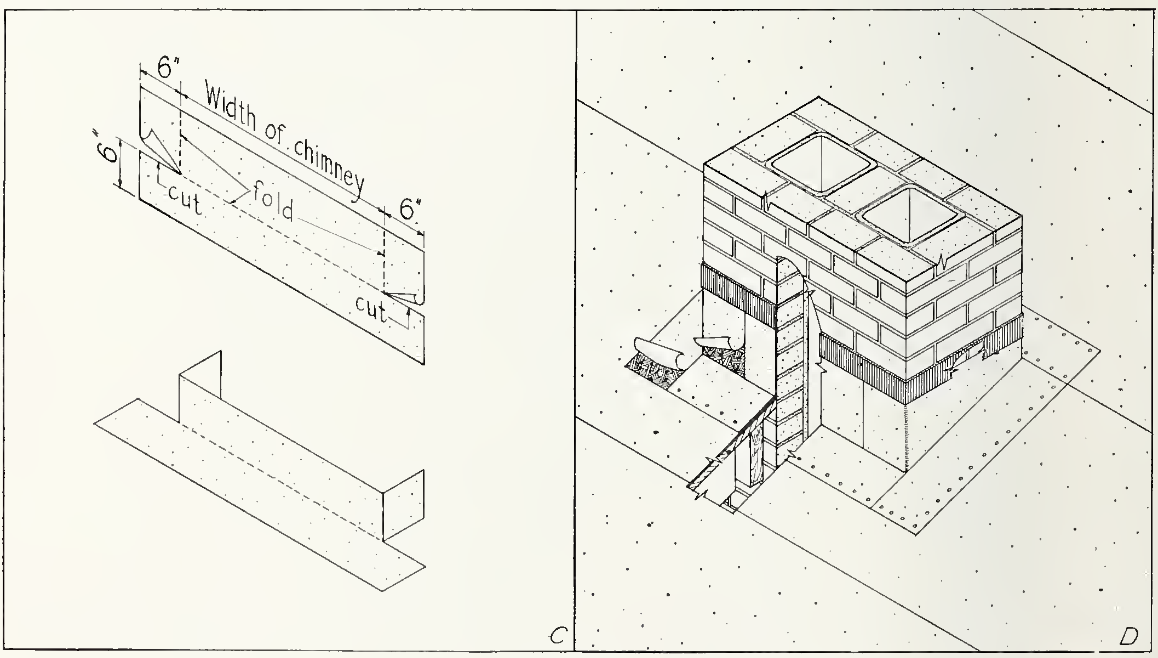

FIGURE 19.

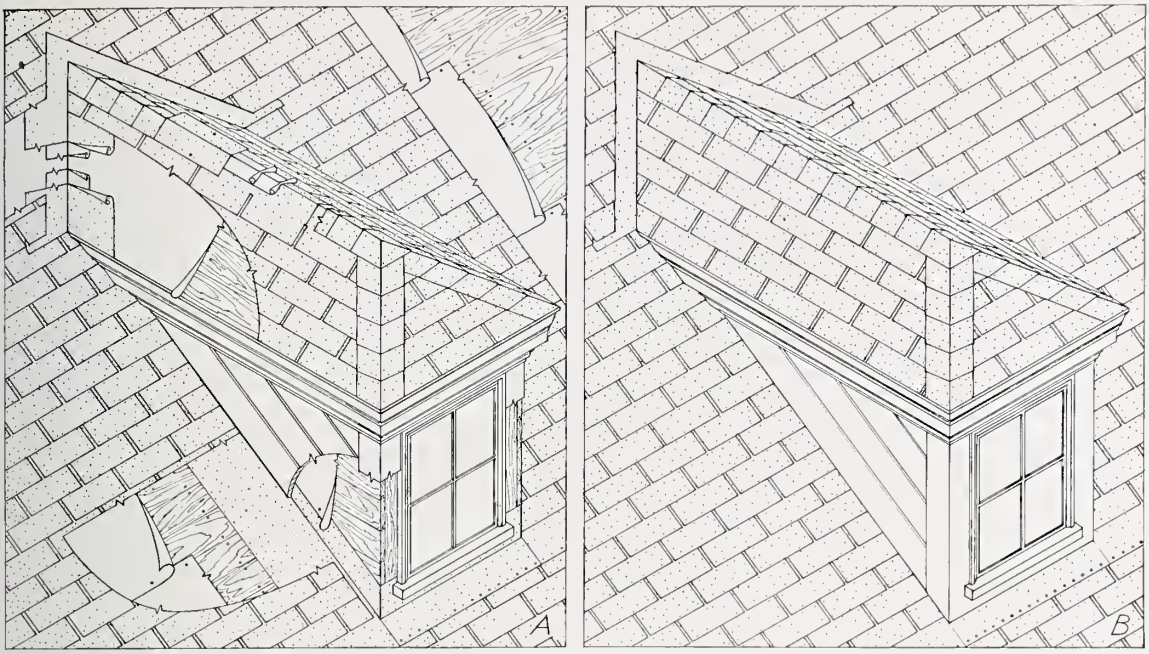

FIGURE 20.

larly roll roofings, should never be applied at temperatures below 40° F.

Asphalt shingles are intentionally made more rigid than roll roofings and if applied during cold weather consideration should be given to this fact. When it is necessary to fold shingles, as over the ridge of a roof, they may require warming before they are bent.

Asphalt-prepared roofings should never be stored outdoors or in any damp place before application. These roofings are waterproof when applied properly to a roof, but the non-weather side is usually covered with only an extremely thin asphalt coating through which moisture may pass to the saturated felt.

(*b*) *Roof Deck*

The importance of a proper roof deck for asphalt-prepared roofings cannot be emphasized too strongly. All types of these roofings should have a smooth, solid deck in order to render the best service.

New roof decks should be of dry, well-seasoned lumber, because wet or unseasoned boards shrink and warp on drying and cause buckles or wrinkles in the roofing. Ample ventilation of new dwellings should be provided while plaster is drying, otherwise the roof boards may swell and buckle.

Roof boards should be not less than ⅞ in. thick, of uniform thickness, and not more than 8 in. wide. Tongued-and-grooved boards 6 in. wide are preferable, but square-cut boards are satisfactory if they are laid close together and fastened securely. Knot holes in the sheathing boards should be avoided whenever possible but, if present, should be covered with tin.

Asphalt-prepared roofings are frequently applied over old wood shingles and when laid properly, usually give satisfactory results. One of the main objections to this practice is that it is not possible to secure proper nailing since most wood shingles are laid on so-called shingle lath that are spaced several inches, so that some of the nails used to fasten the new roof do not strike the shingle lath. Another serious objection is that a wood-shingle roof does not present a smooth surface. This may be obviated in part by replacing any decayed or missing shingles and nailing down or cutting off corners of any shingles that are warped. Beveled wood strips nailed over the old wood shingles also help to secure a smooth deck. These strips should be about 4 in. wide, with the thick side as thick as the butts of the wood shingles (fig. 9). The best practice, however, is to remove the wood shingles, taking care that

all nails used to fasten them are removed, to clear away any debris, and to fill in the spaces between the shingle lath with wood strips of the same thickness as the lath.

(c) *Valleys*

Valleys are usually constructed of roll roofings, although metal valleys may be used satisfactorily if provision is made for changes in dimensions with changes of temperature. The chief advantage of the use of roll roofings for valleys is that the entire roof is covered with the same type of material, so that differences in the rate of expansion and contraction with changes of temperature do not exist.

When roll roofing is used for valleys, it is used in double thickness. The first layer should be preferably 18 in. wide, and, if it is a mineral-surfaced roof, should be laid with the exposure side down. The second layer should be the full width of the roll (36 in.) and should be laid with the weather side up. Each sheet should be made to lie smoothly and conform to the contour of the roof. Valley sheets should be nailed at intervals of approximately 18 in. to hold them in place until the remainder of the roofing is applied. (See fig. 17.)

One manufacturer recommends two strips of roofing for valleys, the first 9 in. wide and the second 18 in. Another recommends strips 16 and 20 in. wide. The advantage of the wider strips is obvious.

(d) *Edging*

Some method of protecting the edges of the roof deck at the eaves and gable ends is desirable. The method recommended most generally for new roof decks is the application of galvanized-metal strips, painted on both sides. These strips should be at least 3 in. wide, and should extend ½ in. beyond the edge of the roof to form a drip edge (figs. 3, 7, and 12). Another method is to apply strips of roll roofing at all edges (fig. 1). These strips should extend about 4 in. on the roof proper, and should be bent over and nailed securely to the edges of the sheathing and fascia boards and extend about ½ in. beyond to form a drip edge. Frequently a course of wood shingles is applied at the eaves, with the butts of the shingles extending about ⅜ in. beyond the sheathing board to form a drip edge (fig. 8).

In applying asphalt-prepared roofings, over wood shingles, it is good practice to cut away the wood shingles at the eaves and gables for a space of 4 in. and install wood strips ⅞ in. thick and 4 in. wide. (See fig. 9.)

2. Roll Roofings

This section does not propose to give complete details of the application of roll roofings and shingles, because, as mentioned previously, adequate instruction sheets always accompany shipments of these materials. It is intended merely to emphasize some of the more important details of installation.

(a) *General Instructions*

Asphalt-prepared roll roofings are usually furnished in sheets 36 in. wide. Rolls of smooth-surfaced roofings contain 108 or 216 sq ft; rolls of mineral-surfaced roofings only 108 sq ft. A small proportion of the rolls may contain two pieces of roofing, in which case slightly more than 108 sq ft is furnished in order to provide for the additional lap where the ends of the two pieces must be joined together.

Nails and lap cement are provided with each roll of roofing. These are usually placed in the center of the rolls, which are wound tightly and wrapped with paper. The ends of the rolls are normally closed with caps, which protect the roofing and prevent the nails and lap cement from being lost.

Metal caps, or other similar fixtures intended to fasten the seams more securely, are used frequently, particularly with smooth-surfaced prepared roofings.

Considerable care should be taken in unrolling the rolls of roofing. The wrappings and caps should be removed and the "trimmings" (nails and lap cement) taken from the roll. Then, while the roll is standing on end, each convolution should be loosened by passing the hand between the layers from one end of the sheet to the other. The roll should then be laid flat and unrolled slowly.

Manufacturer's instructions should be followed as to whether the surface on the inside or

outside of a roll of smooth-surfaced prepared roofing should be exposed to the weather.

Mineral-surfaced roofings are always rolled with the exposure surface on the inside of the roll. A safe practice with both smooth- and mineral-surfaced roofings is to cut the strips to proper length and lay them on a smooth, flat surface for several hours, or until they lie perfectly flat.

Roll roofings are usually laid horizontally.[10] They may, however, be laid vertically on slopes greater than 4 in. per horizontal foot.

(*b*) *Pitch of the Roof*

The recommendations of manufacturers concerning the minimum pitch of roofs on which roll roofings may be laid with safety vary from "a slight pitch" to 4 in. per horizontal foot. It can be taken as axiomatic that the greater the pitch the better the service that may be expected from the roof. A probable safe minimum pitch for roll roofings laid by the horizontal method and lapped 2 or 3 in. is 4 in. per horizontal foot; and for roofs laid vertically, 6 in. per horizontal foot.

If it is necessary to use roll roofings on roofs with lower pitch, the lap should be increased proportionately. Some manufacturers recommend the use of the so-called split-surface or wide-selvage roofings, where but half of the sheet is surfaced with granules, figure 2, or regular smooth-surfaced roll roofings lapped 1 in. more than one-half the width of the sheet on very low-pitched roofs.

(*c*) *Horizontal Application*

In laying roll roofings horizontally with nails exposed, one should start at the lower edge with a full-length sheet, laying it parallel to the eaves (fig. 1). If a metal edge strip is used, the lower edge of this sheet should project about ½ in. beyond the edging strip. If a strip of roll roofing is used at the edge, that part of the edging strip on the roof proper should be coated with lap cement, and the first sheet of roofing laid flush with the edge at the eaves and rake. This sheet should be fastened with nails spaced about 24 in. apart and 1 in. from the top of the sheet.

The second course should be started by a half-length sheet, in order to break joints, lapping this sheet 2 in., or more if desired, over the first, and nailing along the upper edge as described for the first sheet. Laps at the ends of sheets should be at least 4 in., and, preferably 6 in., wide.

The third course should be started with a full-length sheet and succeeding courses proceed up the roof, to the ridge, starting alternately with full- and half-length sheets. The top sheets from each side of the roof should extend at least 3 in. over the ridge and be nailed securely.

Lap cement should be applied liberally and continuously to that part of the upper edge of the sheet that will be lapped by the sheet above. Care should be taken that the sheets lie perfectly smooth and flat before the seams are cemented. The lap cement should be allowed to become tacky before the seams are nailed. Horizontal seams must always be lapped shingle fashion to shed water and vertical seams must be lapped away from prevailing winds.

The nails used to fasten the seams should be ¾ in. long on new roof decks, with heads not less than ⅜ in. wide. The nails furnished with roofings are usually galvanized, those with a heavy coating of zinc being most desirable. Nails 1½ in. long should be used when roll roofing is applied over old wood shingles.

The nails should be spaced 2 in., from ¾ to 1 in., from the edge of the sheet in long seams, and 1 in. staggered in short vertical seams (end laps). Care must be taken not to drive nails in cracks between boards in old roof decks. If cracks are present, it is a good practice to mark their location on the sheets.

(*d*) *Blind Nailing*

Roofings laid by the blind-nailing method, with no nailheads exposed, are laid as above, except that the laps must be greater than 2 in. This method is best adapted to smooth-surfaced roll roofings and the mineral-surfaced roofings with an unsurfaced selvage at least 3 in. wide. Each sheet is securely nailed along the top edge

[10] The terms "horizontal application" and "vertical application" are used generally in the roofing industry, the former to indicate that the sheets are laid parallel with the eaves; the latter, that they are laid perpendicular to the eaves.

with nails spaced 2 in. apart and in the center of the part to be lapped. If a lap wider than 3 in. is employed, the nails should be staggered. Seams laid by the blind-nailing method should be weighted down until the lap cement has set thoroughly. Bricks, bags of sand, or weighted planks may be used for this purpose.

Wide-selvage roofings, as illustrated in figure 2, are always laid by the blind-nailing method. The wide laps may be cemented with cements applied cold that are prepared specifically for this purpose, or a mopping of hot asphalt, similar to that used in the construction of built-up roofing, may be employed. The selvage should be fastened with two courses of nails, the first about 2 in. and the second about 9 in. from the surfaced edge of the sheet. The nails should be spaced about 8 in. and the two courses should be staggered. If cold-application cement is used, the laps should be rolled with a heavy roller to insure a smooth surface and a satisfactory bond between the sheets.

(*e*) *Vertical Application*

In general, the directions for horizontal application apply to vertical application of roll roofings, except that the sheets are started from the ridge, where they are temporarily fastened with 3 or 4 nails, and unrolled toward the eaves (fig. 3). The sheets should be allowed to hang free until they lie smoothly before the laps are cemented and nailed.

Vertical application of roll roofings is usually considered less desirable than horizontal application, because water must run along the laps instead of over them. Over old wood shingles, manufacturers seldom recommend vertical application of roll roofings because of the difficulties of securing proper nailing and smooth application. However, a system of vertical application over old wood shingles has proved quite satisfactory in some localities. With this system, wood strips, as illustrated in figure 4, are nailed vertically to the roof through the wood shingles and thus provide a proper, solid base for nailing the roofing seams. The seams are elevated above the remainder of the roof by the thickness of the beveled strips, so that water tends to drain away from them. The fact that the seams are raised slightly relieves the monotonous appearance of the usual roll-roofing roof.

(*f*) *Hips and Ridges*

Hips and ridges may be finished with a strip of roll roofing not less than 18 in. wide, bent over and fastened on each side and nailed as described for long seams; or they may be finished with individual asphalt shingles, as illustrated in figure 17. Some manufacturers recommend a double thickness of roofing at hips and ridges, in which case the first strip needs to be nailed only at intervals of about 18 in.

(*g*) *Flashings*

Flashings at chimneys, vent pipes, and against vertical walls of dormers are of extreme importance. Figures 18 and 19 illustrate a satisfactory method of installing chimney flashings, using roll roofing except for the metal counterflashing. Pieces of roll roofing 4 in. square should be cut and fitted as shown in figure 18 (*A*). The roll roofing is then laid in the usual manner, cementing the turned-up edges against the chimney as in figure 18 (*B*). Strips of roofing 12 in. wide are then cut for each side of the chimney, making each strip about 12 in. longer than the side to be flashed. The strips should be cut and folded as indicated in figure 19 (*C*). These strips should be placed around the four sides of the chimney and should be cemented thoroughly to the chimney and to the roofing underneath. The flashing should be fastened at the top with a metal counterflashing and to the roof with nails spaced 2 in., and ¾ in. from the edge (fig. 19, *D*).

Against vertical brick walls, the roofing should be turned up about 4 in. and cemented and nailed to the wall, placing the nails about 8 in. apart. A strip of roofing 12 in. wide, bent in the center lengthwise, should be fitted into the angle and cemented thoroughly to the wall and the roof. It may be fastened to the wall by means of a wooden strip, either half-round or beveled, which is nailed securely and the upper edge puttied with plastic cement so that the joint is sealed and the water drains away from the edge. A metal counterflashing is preferable to the wooden strip and should be used whenever possible. It may be of copper,

galvanized iron, or terne plate set into the wall and extending at least 6 in. down over the flashing strip. If galvanized iron or terne plate is used, it should be well painted on both sides.

Against dormers covered with asphalt shingles or wood siding, the roll roofing and the 12-in. strip should extend up under the siding material.

3. Asphalt Shingles

Asphalt shingles are usually marketed in packages, weighing from 40 to 100 lb. each. Two to four packages are required to cover one square of roof, depending on the design of the shingles.

(a) *Pitch of the Roof*

The class *C* label of the Underwriters' Laboratories, Inc. is applicable to asphalt shingles only when they are laid on inclines exceeding 4 in. to the horizontal foot.

Manufacturers recommendations vary considerably in respect to the minimum pitch of asphalt shingle roofs, although the majority advise not less than 4 in. per horizontal foot. One manufacturer states that 5 in. per horizontal foot is the minimum for shingles; another that they are not guaranteed if applied on slopes less than 3 in. to the foot; another that if they are applied on slopes less than 4 in. to the foot, the roof deck should first be covered with smooth-surfaced asphalt-prepared roofing; another that 4 in. per foot is the minimum for most shingles but that hexagonal-pattern strip shingles less than 14-in. long should not be laid on inclines of less than 6 in. to the horizontal foot.

The importance of having sufficient slope to the roof deck is greater with asphalt shingles than with roll roofings, because the latter, when laid properly, provide a continuous sheet over the entire roof. Asphalt shingles, while furnishing, in many cases, two or three layers of fabric over the greater part of the roof area, are not continuous, and so have to be designed and applied properly in order to prevent leaks. For this reason 5 in. per horizontal foot is recommended as the minimum pitch for asphalt-shingle roofs. Numerous observations have shown that the waterproofness and weather resistance of asphalt-shingle roofs increase as the pitch of the roof is increased. Porch roofs are excepted because they are usually lower pitched than the main-roof sections.

(b) *Underlay*

If asphalt shingles are applied to new roof decks, manufacturers are practically unanimous in recommending some type of covering for the roof deck before the shingles are laid. The materials recommended most generally are 15-lb asphalt-saturated felt or asphalt-saturated and coated building paper. Reasons given for the use of underlay materials are: increased waterproofness and heat insulation, protection for the sheathing boards before the shingles are applied, and increased life of the shingles.

Whether or not an underlay material is necessary from the standpoint of waterproofness is dependent mainly on the type of shingle and the pitch of the roof. Shingles that furnish triple coverage over the greater part of the roof deck and have an ample headlap (4 in. or greater) need no underlay material to make them waterproof when they are laid on inclines of 5 in. per foot or more. The underlay material may also be omitted on inclines of 7 or more inches per foot, provided that the weight of the shingles is not less than 210 lb per square.

Light-weight prepared roofings or coated waterproofing papers are probably more satisfactory for this purpose than asphalt-saturated felt, since the latter will usually absorb considerable moisture.

The actual heat-insulation value of felts and papers used as underlay materials, compared with that of materials that are marketed regularly for insulation purposes, is so small as to be almost negligible. They act as a moisture barrier to prevent possible condensation on the under surface of shingles and serve to prevent air infiltration and heat losses through cracks in sheathing boards.

(c) *Edging and Starting Strips*

The edges of the roof deck at gables and eaves should be protected by some sort of edging strip extending slightly beyond the edges of the boards to form a drip edge. This is particularly true at the eaves, where the boards will soon rot unless water is prevented from coming in

contact with them. A galvanized-metal strip painted on both sides, projecting ⅜ to ½ in. beyond the edge, and extending about 4 in. on the main section of the roof, as illustrated in figures 3, 7, and 12, is usually recommended. A course of wood shingles laid close together with the butts extending about ⅜ in. beyond the edge of the sheathing boards may be used satisfactorily at the eaves (see fig. 8).

At the eaves it is customary to lay a strip of roll roofing flush with the edging strip. Some manufacturers recommend 12-in. strips, others 18-in. Figures 7, 8, 10, 12, 13, 14, and 16 illustrate an 18-in. starting strip, but a full 36-in. strip is most desirable, particularly where the eaves project beyond the walls a considerable distance. This strip should be nailed about 2 in. above the edging strip at such intervals that the nails will not be exposed when the first course of shingles is laid. It should not extend over any valley strips. Where there is much snowfall, a good plan is to use a metal eaves strip that extends about 36 in. over the main roof section.

Frequently a course of strip shingles, reversed, is laid in place of the strip of roll roofing, as in figure 15, or a course of individual shingles, laid close together, is used (figs. 9 and 11).

(*d*) *Nails and Clips*

Galvanized nails, with heads not less than ⅜ in. in diameter and with barbed or plain shanks, 11 or 12 gage, are usually recommended for asphalt shingles. Recommendations concerning the length of nails that should be used vary with different manufacturers. Table 5 lists nails that may be used safely with the different kinds of shingles for various conditions of application.

TABLE 5.—*Nails used for asphalt shingles*

Roof deck	Standard-weight	Giant-weight	Thick-butt
	in.	*in.*	*in.*
New	1 to 1¼	1 to 1¼	1⅛ to 1¼
Weathered-roll roofings	1¼ to 1½	1¼ to 1½	1½ to 1¾
Weathered-asphalt shingles	1½ to 1¾	1½ to 1¾	1½ to 1¾
Weathered-wood shingles	1¾	1¾	1¾

The clips that are used for fastening the butts of shingles, and the corners of shingles laid by the Dutch-lap method, are usually patented features, requiring a special tool for installing them. No attempt will be made to describe them here. They usually accomplish the purpose for which they are intended—namely, that of preventing the shingles from being raised by high winds. Most clips penetrate the exposed portion of the shingle and thus furnish a means for water to reach the felt base of the shingle at the point the clip penetrates.

(*e*) *Hips and Ridges*

Hips and ridges are best finished with individual shingles although strips of roll roofing or metal ridge rolls may be used. In finishing hips with individual shingles, it is desirable to first lay a double layer of asphalt-saturated felt 6 in. wide, as shown in figure 17. The shingles are then applied in the same manner as on the roof, starting at the lowest point and bending the shingle equally across the hip. One nail is placed on each side, about ¾ in. from the edge. The shingles used to finish the hips should be kept in line with the courses of the main roof, exposing standard-weight shingles 4 in. and heavy-weight shingles 5 in. (See fig. 17.)

Ridges are finished in the same manner as hips, always starting from the direction opposite that of the prevailing winds (fig. 17).

Shingles for finishing hips and ridges may be cut from strip shingles by trimming each shingle to the edge of the cut-out section, if individual shingles are not available.

(*f*) *Flashings*

Chimney flashings may be constructed as illustrated for roll roofings, figures 18 and 19, except that the flashing strips should be installed before the shingles are laid, so that the strips will extend underneath the shingles except at the bottom of the slope. Metal flashings and counterflashings, as shown in figure 17, are preferable to those made from roll roofings.

Figure 20 (*A*) shows a method of installing flashings around the vertical walls of a dormer, using an 18-inch strip of roll roofing bent so that the section underneath the asphalt shingles is 12 in. wide. Figure 20 (*B*) shows the completed dormer.

(g) Methods of Applying Particular Types of Shingles

As stated previously, no attempt will be made to describe exact methods for applying all types of shingles, as these are covered adequately by the instructions issued by the manufacturers. However, some of the more important details are summarized here.

(1) *Individual shingles—American Method.*

In laying individual shingles by the American method, as illustrated in figures 7 and 8, standard-weight shingles are usually spaced ½ in. and heavy-weight shingles ¾ in. The spaces between shingles in successive courses may be staggered one-half (fig. 7) or one-third (fig. 8) the width of a shingle. For the former method, the first course is started with a full-width shingle, the second with a half-width shingle, the third with a full-width, etc. For the latter, the first course is started with a full-width shingle, the second with two-thirds of a shingle, the third with one-third of a shingle, the fourth with a full-width shingle, etc. The latter method provides the better coverage.

A safe rule to follow is to expose standard-weight shingles not more than 4 in. and heavy-weight shingles not more than 5 in. Nails are placed as indicated in figures 7 and 8.

(2) *Individual Shingles—Wide-Space, Hexagonal, and Dutch-Lap Methods.*—The wide-space, hexagonal, and Dutch-lap methods of applying individual shingles (figs. 9, 10, and 11) should not be employed except for reroofing over weathered-wood shingles or asphalt-prepared roll roofings and shingles. The greater the headlap and sidelap obtained with shingles applied by these methods, the more waterproof will be the roof; but they should not be used on roofs of low pitch nor in regions subject to driving rains.

(3) *Square-butt strip shingles.*

Shingles may be laid so that each cut-out section falls in the center of the tab of a shingle in the next course above, or with the cut-out section one-third of the width of a tab from the cut-out section of a shingle in the course above. Figures 12 and 13 show the effect of shingles laid by the first method; shingles laid by the second method would appear as illustrated in figure 8. The first method is obtained by starting the first course with a full-width shingle, the second with a half-width shingle, the third with a full-width, etc., or by starting the first course with a full-width shingle, the second with a shingle from which one-half tab has been cut, the third with a shingle from which one tab has been cut, the fourth with one from which 1½ tabs have been cut, etc. To obtain the second effect, the first course is started with a full shingle, the second with one from which one-third of a tab has been cut, the third with one from which two-thirds of a tab has been cut, the fourth with one from which a full tab has been cut or with a full-width shingle, the fifth as the second, etc.

Strip shingles are applied so that the ends barely touch each other. They should not be spaced and the ends should not be forced together.

With regard to exposure, the same rule holds for strip shingles as for individual ones—that is, standard-weight shingles are exposed not more than 4 in., heavy-weight and thick-butt shingles not more than 5 in. The length of the cut-out section of a shingle determines the distance of exposure. The ends of the tabs should extend exactly to the tops of the cut-out sections of the shingles in the course next below.

The nails are placed as shown in figures 12, 13, and 14 for normal conditions of exposure. For severe conditions, such as prevailing high winds, driving rains, etc., the shingles will be fastened more securely if the nails are placed as illustrated in figure 15. The extra layer of asphalt and the granules on thick-butt shingles usually extend a short distance above the cut-out sections. The nails should always be placed in the thicker portion of these shingles, which otherwise might suffer damage from winds.

In order to secure smooth application of strip shingles of all types, the nails at the center should be placed first, and then those at the ends; or the nailing may proceed from one end of a shingle to the other. Strip shingles should never be nailed first at the ends and then at the center.

(4) *Hexagonal-pattern strip shingles.*

The first course is started with a full-width

shingle, the second with a shingle from which one-half tab has been cut, the third with a full-width shingle, the fourth as the second, and so on, alternately.

Hexagonal-pattern strip shingles are more vulnerable to driving rains than square-tab shingles. They should always be laid with an underlay material, and should never be applied to roofs of slight pitch.

The distance of exposure of these shingles is also determined by the length of the tabs. The ends of the tabs are laid flush with the tops of the cut-out sections of the shingles in the next course below.

The nails are placed as illustrated in figure 16.

VII. WEATHERING OF ASPHALT-PREPARED ROOFINGS

The weathering of asphalt-prepared roofings is discussed in considerable detail in Building Materials and Structures Reports BMS6 and BMS29. (See footnote, page 2.) These reports also present numerous illustrations of weathered roofings after varying periods of exposure in the Southeastern and Northeastern States. It is apparent from these studies, and from similar studies in other sections of the country, that it is not possible to ascribe a definite "life" to any particular type of asphalt-prepared roofing. With these, as with other roofings, many factors other than the actual materials used must be considered in studying durability. The workmanship used in applying a roof is as important as the quality of the material, because a roof poorly constructed of good or poor materials will never render satisfactory service.

Sunlight, oxygen, moisture, and heat are the principal factors that cause organic materials to deteriorate.[11]

This explains why asphalt-prepared roofings weather more rapidly in warm, humid climates where there is much sunshine, than in cooler, dry climates with less sunshine. Asphalt-prepared roofings exposed in the Northeastern States may be expected to give from 50 to 100 percent longer service than the same materials exposed similarly in the Southeastern States.

[11] O. G. Strieter and H. R. Snoke, J. Research NBS **16**, 481 (1936) RP886.

The foregoing also explains why the southern exposure of a roof, exposed to long periods of sunlight, invariably shows more rapid weathering than the northern exposure; and why mineral-surfaced roofings, with the asphalt coating protected from the sunlight, weather less rapidly than the smooth-surfaced varieties.

Asphalt-prepared roofings weather more rapidly on roofs of low than on roofs of steep pitch. The roofs of porches, which are usually less steep than the main-roof sections, generally show more severe weathering than the main roof. Apparently this is because the flatter slopes are subjected to more severe moisture conditions.

In general, roofings that provide the best coverage resist weathering best. The oldest asphalt shingles in any location are invariably individual shingles laid by the American method.

VIII. MAINTENANCE OF ASPHALT-PREPARED ROOFINGS

1. Smooth-Surfaced Roofings

Smooth-surfaced, asphalt-prepared roll roofings should be recoated regularly to render the best service. The asphalt coating on these roofings, being exposed directly to the sunlight, deteriorates rather rapidly and, unless renewed, will permit water to enter the felt base and hasten failure.

Numerous coating materials are available at a wide range of prices. They are usually described as "Asphalt Fibrous Roof Coatings" and are composed normally of an asphaltic base, with or without fatty (drying) oils, thinned to heavy-brushing consistency with a volatile thinner, and containing mineral filler, usually asbestos fibers. Coal-tar and vegetable-gum (cottonseed-oil pitch) base coatings are also available. Most brush coatings are intended for application at the rate of 1 gallon to approximately 50 sq ft of roof surface.

Two systems for recoating asphalt-prepared roofings have been developed recently. In both of these the roofing is first coated with an asphaltic coating into which mineral granules are embedded. They have been available for only a short time, so that no definite recommendations can be made concerning them.

If recoated regularly, smooth-surfaced roofings may last as long or longer than the mineral-surfaced varieties. The frequency of recoating that is necessary will determine which type is the more economical.

No definite recommendation can be made concerning the frequency of the recoating operation, for this will vary with the different weights of roofings and in different locations. It is reasonably certain, however, that recoating will be advisable after 5 years of exposure, if not earlier. The heavier, thicker grades of roofing will normally resist weathering better than the lighter grades. There is probably greater variation in the behavior to weathering of roofings of this class than in any other put out by different manufacturers.

Particular attention should be paid to the seams of roll roofings that have stood for several years. Any seams that have opened should be recemented; loose nails should be pulled, the holes sealed with flashing cement, and new nails inserted where necessary.

2. Mineral-Surfaced Roofings

Recoating of mineral-surfaced roll roofings is not recommended unless they have weathered badly. The mineral granules protect the asphalt coating from the sunlight, so that normally these roofings should resist weathering for relatively long periods. If coatings are applied to roofings that still retain their granules, the thinner in the coating material may soften the asphalt coating so that it will not retain the granules.

The seams of mineral-surfaced roll roofings should be maintained with the same care as those of smooth-surfaced roofings—that is, they should be inspected regularly and recemented where they have opened. Loose nails should be pulled, the nail holes sealed with flashing cement, and new nails inserted where necessary.

The recoating of weathered asphalt shingles with coating materials of the type recommended for smooth-surfaced prepared roofings is not considered good practice. Cases have been observed frequently where the number of leaks in a roof has been multiplied greatly by the application of a roof coating. This happens most frequently on relatively low-pitched roofs covered with shingles that provide a small headlap. The leaks are apparently caused by failure to seal down the edges of the tabs completely. During driving rains water may be driven under the tabs, which, being sealed partially, will cause it to back up over the top of the shingle underneath. Also, careless application of the coating may form miniature dams at the cut-out sections of shingles.

The systems mentioned under smooth-surfaced roofings, in which mineral granules are embedded in an asphaltic coating, are recommended by those who developed them as suitable for mineral-surfaced roll roofings and shingles.

Shingles that are weathered badly frequently warp or curl after being recoated. Apparently this is caused by the partial absorption of the coating by the shingle, which, not being cemented to the shingle underneath, is distorted when the coating dries. Roofs of badly warped shingles are particularly vulnerable to driving rains.

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IX. SPECIFICATIONS

Federal Specifications: [12]

SS-R-501, Roofing, Asphalt-Prepared, Smooth-Surfaced

SS-R-511, Roofing; Asphalt and Asbestos-Prepared, Mineral-Surfaced

[12] Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., price 5 cents each, stamps not accepted.

SS–R–521, Roofing and Shingles; Asphalt-Prepared, Mineral-Surfaced

Specifications of the Underwriters' Laboratories, Inc.:[13]

Standard for Class C Asphalt Rag-Felt Sheet Roofing and Shingles.

List of Inspected Fire Protection Equipment and Materials.

Specifications of the American Society for Testing Materials:[14]

D224–37T, Tentative Specifications for Asphalt Roofing Surfaced with Powdered Talc or Mica

D225–37T, Tentative Specifications for Asphalt Shingles Surfaced with Coarse Mineral Granules

D248–37T, Tentative Specifications for Asphalt Roofing Surfaced With Fine Mineral Granules

D249–37T, Tentative Specifications for Asphalt Roofing Surfaced with Coarse Mineral Granules

D371–37T, Tentative Specifications for Asphalt Cap Sheet Surfaced with Coarse Mineral Granules.

WASHINGTON, June 11, 1940.

[13] Obtainable from the Underwriters' Laboratories, Inc., 207 E. Ohio St., Chicago, Ill.

[14] Obtainable from the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. For single copies and lots up to 9, 25 cents per copy; lots of 10 to 24, 20 cents per copy; and lots of 25 to 99, 17½ cents per copy.

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[List continued on cover page IV]

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[Continued from cover page III]

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